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Electrical Meters. IT is almost time to hear something definite from the meter competition in Paris. Probably no electrical jury ever undertook a more difficult and thankless task than the examination of an indefinite number of meters with the desire to do justice to all, and, at the same time, to state in cold blood their several performances. Some of them, at least, ought to show admirable qualities; but even if it were possible to pick out one which should be pre-eminently the most exact and reliable, it still might not be the best fitted for commercial service. No inventor is willing to admit that his particular machine is too costly or too complicated for practical success. Its details seem simple to him, and he seldom realizes fully the conditions of every-day service. When the awards are finally made the question of the most successful meter for general use will be left almost as undecided as before. Still, such a competition is not without its good points. It brings prominently before the eyes of every one the weak points of existing meters, and as a rule more can be learned from the study of failures than successes. Inventors will be put actively at work to obviate the difficulties that have been found, and the ultimate result, in spite of present disappointments, will be the evolution of a meter that will fully meet the requirements of the situation. Metering electricity is bound to come into general use sooner or later, and the ingenuity devoted to devising successful means for doing it is not wasted, although the existing conditions may seem hard.

The History of Electricity. IN these days the literature of the science of electricity has grown to such a prodigious extent that to classify and arrange it is almost hopeless. It is more than any one man could accomplish to follow up the electrical history of to-day. The growth of the science up to the present time, however, has not been so great as to defy classification, although little has of late been done toward gathering together in any complete way the work, extending through centuries, that has served as the foundation for modern electricity. Next week we shall take pleasure in publishing the first installment of an elaborate and painstaking history of electricity and magnetism. It will be largely chronological in character, for the time is not yet ripe for the philosophical discussion of such a theme. Beginning with the earliest recorded efforts of man to utilize magnetism, the work will extend over the rise of the science through more than 40 centuries, and, what is better, will not only record the various steps that have been made, slowly and hesitatingly at first, very swiftly of late, but will give elaborate references to original authorities and form the basis from which the student may build up clear ideas of the tremendous intellectual struggles that have resulted in modern electricity, and that, perhaps, may serve at the hands of some historian a century hence as the foundation of a splendid structure, brilliant with the achievements of modern science.

The Mayor and His Little Hatchet. LAST week Mayor Grant took the warpath again against the overhead wires, and with a fresh and almost juvenile delight undertook the task of pole-chopping. The lamented Father of his Country never enjoyed half the comfort in cutting down that cherry-tree that the Mayor seems to extract from the fall of an electric light pole. The work was begun with enthusiasm, but did not proceed altogether unimpeded. Some of the companies prepared a little April fool joke for the force engaged in wrecking their property by leaving on the lines just enough current to make them very hot for meddling fingers. A few legal difficulties, in the way of injunctions, also interfered with the completeness and unity that his Honor has always desired in the destruction of electrical property. However, enough was done to seriously intertere with business in the afflicted districts. The motor service, of course, was paralyzed, and the manufactures dependent upon it temporarily suspended. We do not know whether the Mayor personally superintended any of the work and danced with glee at the merry sound of the falling wood, but he certainly must have rubbed his hands with joy at the success of his boyish mischief. How comforting it is to think that in one respect at least his Honor the Mayor resembles the immortal G. Washington; a predilection for the ax is the common bond that unites souls otherwise far separated both in time and character. Perhaps if Mayor Grant had been George Washington, and George Washington Mayor Grant, however, the finale of the cherry-tree episode might have been somewhat different from that recorded in history.

The Electric Current. PERHAPS there is no subject fuller of stumbling blocks for the student of to-day and the electrician of yesterday than the modern views of the electric current. A century ago, when hypothesis was the comfortable refuge of most scientific men, the searcher after truth could comfort himself by speaking of electricity as a subtle, mysterious, but for the time being rather satisfactory fluid, that somehow managed to flow merrily along through conducting substances. If he were for the moment puzzled by phenomena that occurred outside the wire he could have recourse to the convenient effluvium arising from the aforesaid fluid and disporting itself on surrounding bodies. Those were the days when men had to be content with penning up truth, and looking at it, so to speak, over the fence they had erected. If it showed tendencies to break its bonds the only necessity was to erect a more capacious inclosure with a higher fence. But now we are busily passing from the general to the special, and endeavoring to capture and investigate physical phenomena. The change from the one stage of fact and development to the other occupied in the main less than a century, possibly only half a century. Lavoisier, the father of modern chemistry, was one of the earliest to perceive the necessity of establishing exact quantitative relations between known conditions, but really it was only in the time and largely through the labors of Joule that modern ideas began to replace the older ones. To-day, fifty years later, his work is beginning to bear fruit in electricity. The last five years have been peculiarly rich in the development of facts with which to substantiate various divergent and more or less discordant hypotheses. And, having the facts, it is just now altogether puzzling to know what to do with them. The time is almost ready for some tremendous generalization that shall include electrical energy. What it is no man can now tell; it is not even easy to point out the direction in which to look for it. All this is especially disagreeable for the student, for he feels rather distrustful of the old and uncertain of the new. But for the time being he can do nothing final. To such we would say, acquaint yourselves thoroughly and completely with the general principles of the science, with the work of Faraday and of Maxwell. Very little that has been done by those two great men is likely to fall into disrepute. If you understand their work you have at least a general grasp of the subject that will enable you to appreciate clearly what others may do. Watch the changes as they occur, study the discoveries that are being made day by day; many of them will fall directly in line with what you have already learned. For the rest we must all be students, waiting for more exact knowledge. Perhaps he who begins to learn electricity ten years hence will have fewer difficulties, but it is the place of the electrician of to-day to put himself, if he can, in such a frame of mind that when the time comes for a more thorough understanding of the science of electricity he will not be behind the times and hidebound with venerable traditions.

The Centenary of the Patent System. As we go to press the centennial celebration of the United States patent system is being held in Washington. It has gathered together a large number of distinguished men—scientists, inventors, legal experts, and others who have been identified with the progress of the system that has done so much to further American industries. From the beginning the government has pursued an extremely liberal policy toward the inventors of any new art or apparatus, and the result of this wise encouragement has been, as every one knows, the placing of the United States in the very front rank of mechanical progress. No country is the fortunate possessor of a patent system on the whole so effective in protecting the inventor in the rights that should be secured to him. And yet, with all this—the benefits that have been secured and the admirable regulations that have been put into force—there is an opportunity for great change for the better in patent law and patent practice. There are three weak points to which it is worth while calling special attention. While the government grants to the inventor the exclusive right to the product of his labor, it intends thereby to give him due reward for a public service. The same power that grants this ought to have authority to prevent the rights thus given being used against the public weal. To this end such regulations ought to be made as will effectively prevent the establishment of a monopoly on terms so oppressive as to prohibit the very thing the patent system was intended to further—the invention of useful machines and the devising of useful arts for the benefit of the public, on whose prosperity rests the continuity of any government. A patent right does not necessarily constitute a monopoly, it is true, but is the most effective instrument for creating one. Another very weak point of the present system is the insufficient protection of the rights of foreign inventors. We have fortunately just established an international copyright law; we have taken long steps toward proper reciprocity with other civilized countries; it is already possible for American inventors to obtain valuable patent rights in foreign lands; but in the present state of our patent law it is well-nigh impossible for a foreign inventor to secure a patent if there can be found an American unscrupulous enough to claim the invention, naming a date prior to the foreigner's application in his own country. In other words, years of toil in perfecting a given device are no protection in the rights of invention if an American citizen can be found sufficiently devoid of conscience to file a claim, whatever it may be, on the very eve of the real inventor's hoped-for success. There ought to be such a measure of reciprocity in patent rights that the true inventor would be able to establish the priority of his discovery and secure his patent over all the civilized world quite irrespective of the accident of his nationality. This would benefit American inventors, prolific as they are, even more than foreigners. And there is still a third chance for reform, although it is not altogether easy to carry out. There ought to be some means for the suppression of patents that are not given to the public within a reasonable time after the invention. When exclusive rights are granted to an inventor it is certainly not with the idea of enabling him to withhold his discovery from the public, for whose benefit inventors are encouraged. A large class of patents are taken out and held simply for the purpose of preventing improvements along a given line from being put upon the market. Another group of unused patents are those taken out on general principles, as it were, and never utilized in any way until some other mind has worked out the practical application; then the otherwise useless and impracticable claim is brought out and used to curtail the application of the valuable one. It may be said that the rights of inventors would be seriously trespassed upon if unused patents were to be quashed, but, as a matter of fact, there are few successful inventors who have not suffered more than once in the manner indicated, and who have not found that progress along a certain line was barred by some old claim that has never been put to any service whatever, and neither benefits the public itself, nor permits any one else so to do. It would probably be difficult to devise a system that could entirely avoid the particular difficulties to which we have alluded, but if such a feat could be accomplished the patent system would be both as regards the inventor and as regards the public in a much more satisfactory state. At all events the suggestion is worth thinking about, and, if possible, acting upon in some form or other.

Latest Foreign Electrical News.

(*By Cable from our Regular Correspondent.*)

LONDON, April 6, 1891.—The London-Paris telephone has at last been opened for public service. April 1 was the date when it became generally available, and the charge for three minutes' conversation is eight shillings. There are already three call offices and numerous applications for direct communication from house to house. The financial success of the line is now assured.

The telegraph revenue for the year was £2,380,000, an increase of £60,000 over that of the previous year.

Electric lighting is on the increase. The Portsmouth municipality is about to invite tenders for public lighting, and finally the London companies have gotten to work. The Westminster Electric Supply Corporation came into operation last week with three stations.

Some interesting theoretical work is under way just now. Prof. James Thomson has determined the velocity of the electric discharge in rarefied gas by the revolving mirror method, and found it to be nearly half that of light.

Sir William Thomson, on Friday, gave an address at the Royal Institution on "Electric and Magnetic Screening."

The death is announced of M. Pouyer-Quertier, who was connected with the French cable enterprises for some years.

The cable companies seem to be thriving. Cable rates to Australia will be reduced one-half at the beginning of May.

NEW BOOKS.

THE ELEMENTS OF DYNAMIC ELECTRICITY AND MAGNETISM. By Philip Atkinson, A. M., Ph. D. Pp., 405. 120 illustrations. New York, 1891: D. Van Nostrand & Co., $2.

The present volume is an extended and somewhat meritorious collection of descriptive matter relating to dynamic electricity and magnetism. It is very elementary in character, and contains a considerable amount of useful information that may be of service to the student. Perhaps the best feature is the completeness with which descriptions of some practical forms of apparatus are given. Too many books of this character give merely a general discussion, or descriptions of obsolete forms of machines. For example, few books give any account whatever of Hunning's telephone transmitter, now in most extensive use, especially for long distance work; or of methods and apparatus for electric welding. Nor is it usual to find any hint in elementary works that the electric arc contains carbon vapor, a fact well known to scientific men but generally ignored in practice. In these respects Dr. Atkinson's book possesses very decided merits. Theoretically, however, it adheres to old-fashioned ideas and contains very little that is in line with the recent developments of electrical science. To devote two or three pages to magnetism as a mode of molecular motion, without saying anything of Ewing's researches, or giving any suggestions beyond the range of hypotheses, is to fail in what is a real duty toward the reader. A clear and simple account of the theory of the magnetic circuit might well have supplanted Schoop's theory of accumulators and Tyndall's venerable ideas concerning magneto-crystallic induction, photo-electric generation of electricity and other bits of quasi-scientific bric-a brac.

Particularly, no proper account of the electro-magnetic nature of light and the recent discoveries of Hertz is given, and, indeed, the only suggestion made with reference to the subject is an incorrect one. It will thus be seen that the book, like most others, contains peculiarities both good and bad. Its most useful field is in the instruction of the student and electrical amateur in some of the first principles of the science, and in the everyday forms of apparatus.

APPLETON'S SCHOOL PHYSICS, by J. D. Quackenbos, Alfred M. Mayer, F. E. Nipher, Silas W. Holman and Francis B. Crocker. Pp., 544. Ills., 408. New York, 1891: The American Book Company Price, $1.20.

Every one who is interested in the teaching of modern science has been waiting for some years for the appearance of a thoroughly modern treatise on physics, adapted for the high schools and academies, a stage of instruction before special treatises can be taken up with advantage. The authors of the present work are well known to be thoroughly competent to discuss the subjects that fall to their lot. Prof. Holman treats of mechanics and properties of matter; Prof. Nipher of heat, light, frictional and voltaic electricity; Prof. Mayer of sound, and Prof. Crocker of magnetism and the practical applications of electricity. This ought to be a guarantee of a thoroughly useful and admirable treatise, but after reading the book one cannot help feeling that his ideal has been just missed; principally for the reason that the old canonical lines and the old scholastic ideas have been followed to the bitter end. Probably more students have been thoroughly disgusted with the study of physics by finding a third of the book devoted to rather dry mechanics than have ever been drawn to it by the interest excited by the rest of the volume; and yet the chapters on mechanics and the properties of matter are unquestionably well done in the present volume. What is wanted in the study of physics is a departure from old methods, from time worn illustrations; a presentation of the subject from the standpoint of the ast five years. This long felt want, we regret to say, is not filled by the present volume, in spite of the eminence of the authors. It is, perhaps, hard to say just how the ideal text-book of physics should be written; if it were easy to explain the exact nature of the conditions that must be fulfilled, the book would long since have been before us. We can only say to him who has the temerity to undertake the task, that if he will study the brilliant and luminous expositions of mathematical subjects that were given to the world by the lamented William Kingdon Clifford he may possibly draw therefrom some inspiration for his work on physical science.

ELECTRICAL WORLD PORTRAITS.—XXIII.

DR. JOHN HOPKINSON, F. R. S.

The subject of this sketch is one of the small group of scientific men who combine in an unusual degree theoretical acuteness and practical intelligence. He is a type of practical electrician that is rarer than it should be, for advance in the science cannot be carried forward by those who have only an acquaintance with the art.

Dr. John Hopkinson was born in Manchester, England, in 1849. His early education was mainly at Queenswood College, but before he was 16 years old he entered Owen's College, Manchester, and remained there for a couple of years, when he turned his steps toward Cambridge and Trinity College, that has been the alma mater of a long line of distinguished scientists. In 1870 he was graduated as doctor of science in the University of London, taking as his subject pure and applied mathematics. In the following year he received his degree at Cambridge as

DR. JOHN HOPKINSON, F. R. S.

senior wrangler and first Smith's prizeman. These two honors do not often fall to the same man, as the latter is the severest sort of examination in original work in mathematics. In the next year Dr. Hopkinson published his first original investigation on thermodynamics and internal friction in the vibration of solids. These were contributed to the "Messenger of Mathematics." A little later he read several brief papers before the Literary and Philosophical Society of Manchester. One of these dealt with the changes in the physical properties of iron at low temperatures, and he showed mathematically that cold must increase the tensile strength, but, at the same time, make the metal more liable to break under blows, because the elasticity would be increased at a still greater ratio. This and other theoretical results were amply confirmed by experiments, and showed Dr. Hopkinson's bent toward attacking problems of practical importance, and employing his mathematical powers in working out useful results. In 1872 Dr. Hopkinson accepted the position of engineer with Chance Brothers & Co., lighthouse works, in Birmingham, where he lived until 1878, when he moved to London and began work as an engineer on his own account, still continuing his connection with the lighthouse firm. After his removal to London he gained a high reputation as an expert in patent cases, a work which still occupies no small amount of his time. In 1877 Sir William Thomson communicated Dr. Hopkinson's first electrical paper to the Royal Society. This research dealt with the residual charge of the leyden jar, and the Dielectric Properties of Various Sorts of Glass. Incidentally he showed that the more highly conducting sorts of glass conduct electrolytically at ordinary temperatures. His attention was next turned to a somewhat more theoretical question, the electrostatic capacity of glass, being an attempt to verify some of the principles given by Maxwell with reference to the electromagnetic theory of light. This work was continued for several years, and in 1881 he read still another paper on "The Electrostatic Capacity of Liquids." It was in 1879 that his attention was especially called to the developments of practical electricity, and he produced two papers on electric lighting in that and the succeeding year before the Institution of Mechanical Engineers. The first of these was devoted to experiments made with the Siemens dynamo to determine its efficiency under varying conditions, and during this research he laid out the curves that are now familiarly known as characteristics. The second paper continued the same line of brilliant investigation. But it was not until 1883 that their author was fairly embarked on practical electricity. It was at that time that he turned his attention toward the improvement of the Edison dynamo, and worked out the very perfect and highly efficient form that has been known as the Edison-Hopkinson machine. Since that time Dr. Hopkinson has produced a brilliant series of investigations on the theory and practice of electrical science. Perhaps the most notable of them was that on "Dynamo Electric Machinery," read before the Royal Society, May 6, 1886. The work was done in connection with Dr. Edward Hopkinson, and its result was to put the design of dynamos on a sound basis.

It is the fundamental paper in the theory of dynamo electric machines, and during the past five years it has had an almost incalculable effect in improving electrical designing and laying the foundations of innumerable practical applications. The research is unique in the immense condensation of important facts and theories it contains. Scarcely less brilliant, however, was his paper on "The Magnetization of Iron and Steel." Not a few results that have been arrived at by experimenters at the cost of long months of arduous labor might have been jumped at direct had this research been better known in this country than it was. Since 1885 Dr. Hopkinson's work in practical electricity has been constant and far reaching. Perhaps his latest achievement may be said to be the successful inauguration of the City and South London Railway, of which he was one of the consulting engineers. Still a young man, barely over 40, it is safe to predict that his brilliant career will be continued for many years to come, and that more than ever he will bring his immense mathematical resources and severe theoretical training to the service of electrical progress. Two lessons are worth learning from this brief sketch of his life: First, that contrary to what a certain part of the public would have us suppose, it is not altogether impossible for a brilliant theoretical mathematician to be possessed of and to utilize very practical knowledge; and, second, that even in the midst of the busiest professional career it is possible to conduct investigations in pure science. Lessons like these are specially worth remembering in a country like our own, which is apt to put science for its own sake and theoretical training very much at a discount.

Moonlight Tables for April, 1891.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of April, under his modified form of moon schedule. Central station managers will find them of considerable value, as we have good reason to believe that many have profited by them.

TABLE NO. 1. Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Extinguish
1	6:55 P.M.	2	12:50 A.M.
2	6:55	3	3:45
3	6:55	4	4:30
4	6:55	5	4:45
5	7:00	6	4:35
6	7:00	7	4:35
7	7:00	8	4:35
8	7:00	9	4:30
9	7:00	10	4:30
10	7:05	11	4:30
11	7:05	12	4:25
12	7:05	13	4:25
13	11:20	14	4:25
14			
15	12:15 A.M.	15	4:20
16	1:00	16	4:20
17	1:35	17	4:20
18	2:10	18	4:20
19	2:35	19	4:15
20	3:00	20	4:15
21	3:25	21	4:15
22	No light.	22	No light.
23	No light.	23	No light.
24	No light.	24	No light.
25	No light.	25	No light.
26	7:20 P.M.	26	10:40 P.M.
27	7:20	27	11:45
28	7:20	29	12:15 A.M.
29	7:20	30	1:45
30	7:25	1	2:30

Total hours lighting, 159.40.

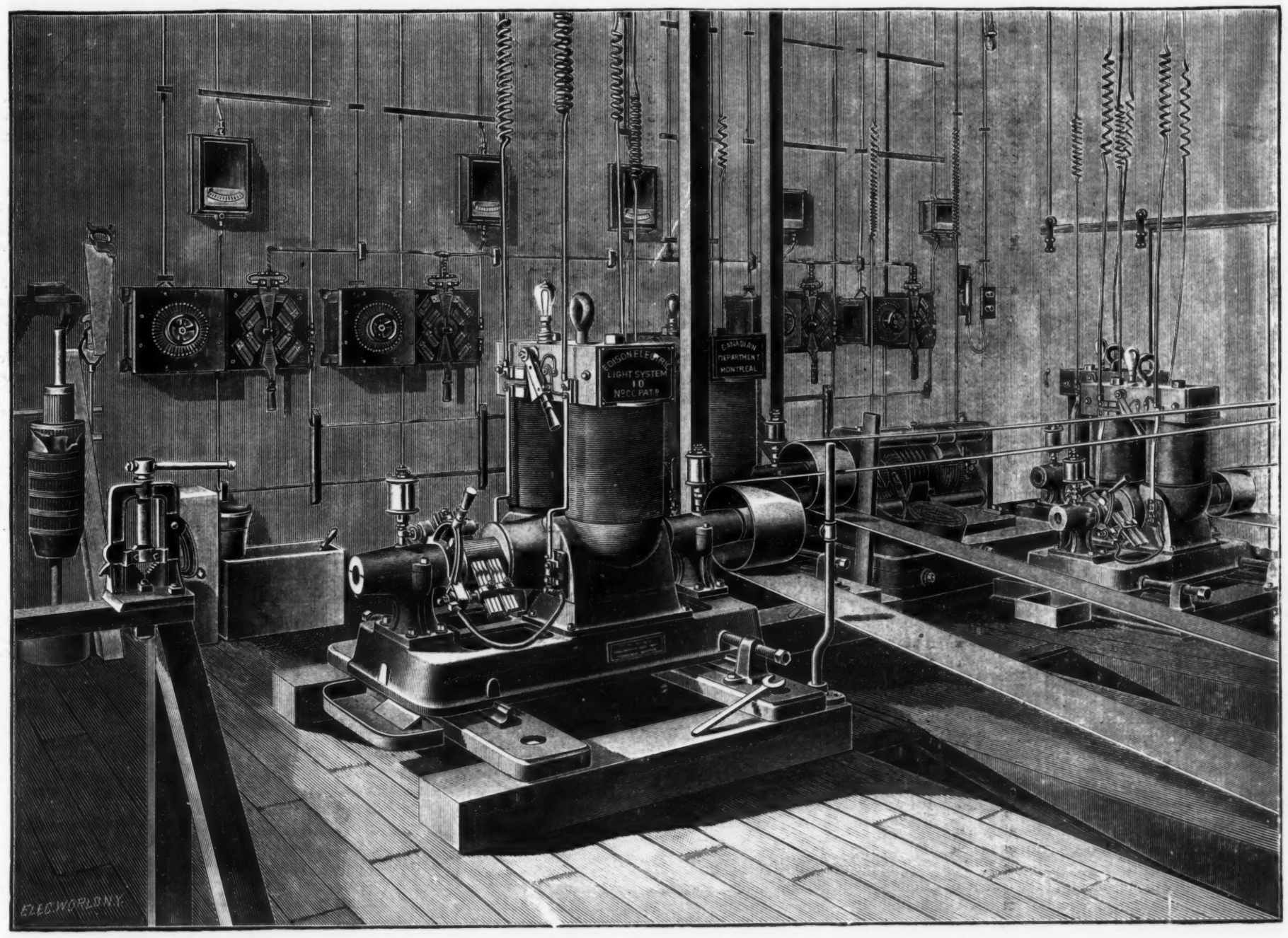
TABLE NO. 2. Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	6:55 P.M.	2	2:50 A.M.
2	6:55	3	3:45
3	6:55	4	4:30
4	6:55	5	4:40
5	7:00	6	4:35
6	7:00	7	4:35
7	7:00	8	4:35
8	7:00	9	4:30
9	7:00	10	4:30
10	7:05	11	4:30
11	7:05	12	4:25
12	7:05	13	4:25
13	7:05	14	4:25
14	7:05	15	4:20
15	7:10	15	12:00 M.
16	1:00 A.M.	16	4:20 A.M.
16	7:10 P.M.	16	12:00 M.
17	1:35 A.M.	17	4:20 A.M.
17	7:10 P.M.	17	12:00 M.
18	2:10 A.M.	18	4:20 A.M.
18	7:10 P.M.	18	12:00 M.
19	2:35 A.M.	19	4:15 A.M.
19	7:15 P.M.	19	12:00 M.
20	3:00 A.M.	20	4:15 A.M.
20	7:1 P.M.	20	12:00 M.
21	7:15	21	1:00
22	7:15	22	12:00
23	7:15	23	12:00
24	7:15	24	12:00
25	7:15	25	12:00
26	7:20	26	12:00
27	7:20	27	1:00
28	7:20	28	12:00
29	7:20	30	1:40 A.M.
30	7:25	1	2:30

Total hours lighting, 221.55.

The Electric Light Central Station at Victoria, B. C.

We have from time to time illustrated in THE ELECTRICAL WORLD some of the electric light stations which are at present in operation on the Pacific Coast. Some of these are of interest because of their remarkable size and the excellence of their installation. The illustration which is presented on this page shows a typical Edison plant as installed in the far West. It is operated by the Victoria Electric Company, of Victoria, B. C., and is situated on Langley street in that city. The electrical equipment, as will be seen by the cut, consists of two No. 10 Edison incandescent dynamos and two No. 6 of the same type, besides a 50 light arc machine of the Ball type. The incandescent plant is operated on the three-wire system. The interior of the dynamo room is admirably arranged. The switchboard is very neat in appearance, and is constructed in the most convenient manner possible. At the left of the illustration will be seen a spare armature, which is kept ready for use in case of accident to any one of those in operation. The entire arrangement of the station is first-class in every respect, and the excellent appearance of its machinery and all the station accessories reflects great credit upon the management.



DYNAMO ROOM OF THE VICTORIA ELECTRIC COMPANY'S CENTRAL STATION AT VICTORIA, B. C.

The Action of Electric Currents on the Human Eye.

Professor Dubois, of Berne, says *Nature*, has been lately studying the physiological action of electric currents and discharges, and he has some interesting observations on the human eye, which, it is known, has luminous sensations under the action of galvanic currents. Sudden variations of current strength, especially at making and breaking the circuit, produce flashes. With a moistened plate at the nape of the neck, and a pad on the eye, a slight flash was distinctly perceived even with a Leclanché cell, giving about 1.20 volt and .04 milliampère. Raising the current to .5 milliampère, the observer could tell which pole was applied to the eye. On the other hand, the retina responds much less readily to discharges from condensers or induction coils. Not till a capacity of 0.037 microfarad and a pressure of 21 volts was reached, was a true retinal flash perceived; and not even with 10 microfarads were the durable sensations characteristic of the two poles produced.

Transformer Distribution.*

BY J. SWINBURNE.

DISTRIBUTION.

Even with the most efficient transformers, the house system is a very poor method of distribution. Apart from the question of loss of power, consider the outlay involved in providing each consumer with a high-pressure double-pole fuse, a transformer, an automatic device for rendering the whole arrangement safe in case of insulation giving way, perhaps a double-pole main switch, a meter, and a fire-proof safe in which all these things have to be inclosed. In addition to this, it involves a complete high-pressure parallel system of distribution, and a network of 2,000-volt underground mains involving a heavy outlay, and probably heavy depreciation. The adoption of sub-stations is generally regarded as the cure for all this. I believe no sub-station distribution is in use, or even in construction, in this country. The London Electric Supply Company are using sub-stations, but not in this way. These sub-stations merely transform from 10,000 to 2,500 volts, and the distribution itself is carried out by means of house transformers. The principle of sub-stations is that the town has a network of low-pressure mains, with low-pressure feeders led to sub-stations. In each sub-station there are attendants who regulate the pressure in the network, as they have control of the feeders. The sub-station is supplied by high-pressure mains from the station, the power being transformed to low pressure at the sub-stations. There is, however, no need for sub-stations; the low-pressure network may be fed at various points by transformers and feeders coming direct from the station. These transformers need not be in houses or cellars; they can be placed conveniently in the ground in cases filled with insulating oil. The method of feeding into a low-pressure network was described in Mr. Kapp's paper on transformers in 1888, and he referred to it as being in use on the Continent and in America. At the station each feeder can be regulated, and has a compound-wound voltmeter, so that an attendant can keep the pressure in the whole town constant. As Mr. Kapp pointed out, the advantage of such a system is enormous. In direct currents the low-pressure mains must be large. The great size needed for parallel distribution was pointed out at the time of the Electric Light Act of 1882, and Professor Forbes afterwards went into the matter much more fully; but even now the enormous saving that can be effected by using small low-pressure mains fed at frequent intervals seems hardly to be realized.

In beginning in a new district it may be objected that the subscribers at first are so few that it does not pay to put down low-pressure mains. This would be true if alternate low-pressure had to be as large as direct-current mains. Without going into the cost of a particular case, it is probable that low-pressure mains large enough to supply any demand likely to arise for many years can be put down for little, if any, more than the high-pressure network with its expensive insulation. Even in scattered districts it would generally pay to use small low-pressure mains and feeders. The alternate system has so many advantages over the direct in the matters of regulation and distribution, when worked on the low-pressure system, that it is astonishing that such arrangements are not utilized. For instance, with direct currents, it is most difficult to find a leak; and one leak on the positive at the west end, combined with one leak on the negative at the east, will cause serious trouble. With alternate currents, a number of small local networks may be used, each of them being complete in itself. It is not in metallic connection with any other part of the town, nor with the central station. Where it meets the network of the neighboring district it is not metallically joined, as in the case of direct currents, but is connected through a one-to-one transformer sunk in the ground in a case full of oil.

After the clear and able manner in which Mr. Kapp urged the advantages of low-pressure networks for alternating currents, it is most astonishing that engineers should go on with house transformers. With the low-pressure network system we have everything that can be wanted: perfect regulation at every point throughout the town, small mains, inexpensive insulation, cheap and efficient plant, and—what is of importance in comparison with battery work—simple and inexpensive switchboards. There is no trouble from general ground leak; and both arc and incandescent lighting can be done from the same leads. The only thing wanting is storage; and to what extent is that really necessary, and what does it cost? It is significant that throughout America, where direct-cur-

*A paper read before the Institution of Electrical Engineers, London; concluded from THE ELECTRICAL WORLD of April 4, 1891.

rent stations could have it for the asking, it is never used. At present, however, we are using alternating currents in just about the worst way that could be possibly devised.

CONDENSERS.

Condensers frequently figure in electric light literature, but they are only put forward as possible means for transforming currents. Direct currents and interrupters are generally discussed. Condensers may, however, have another very large opening in connection with ordinary alternate current distribution. Take, for instance, the case of arc lamps. It is customary, whenever possible, to run arc lamps in long series with high pressures, generally with direct currents. In many cases such an arrangement is very convenient; but wherever there are incandescent lamps to be fed at the same places as the arcs, it is, of course, wasteful to run two sets of engines, dynamos and leads. With direct currents this is sometimes necessary, for arc lamps in parallel do not burn well on 100-volt circuits, and must be used two at a time; and at 50 volts resistance is needed in series, which is wasteful. With alternate currents nothing is easier than to run lamps with choking coils. If the supply is high pressure, each lamp can have its own transformer, and the transformer can be wound for nearly constant secondary current. Prof. E. Thomson has brought out several forms of constant-current transformer, and so has Mr. Tesla. The "hedgehog" form, however, lends itself especially well; all that is necessary is winding the coils one at each end, instead of one over the other. Whether the mains are high or low pressure, choking coils or constant-current transformers will give rise to large currents at the station, which will lower the output of the machines.

For instance, suppose a station supplies a 100-volt secondary circuit by means of transformers with 2,000 volts primary pressure; and suppose there are 200 arc lamps, each taking 33 volts and 10 ampères, arranged on the 100-volt circuit, with a choking coil in series with each. Suppose, for simplicity, that there are no incandescent lamps in use. The arc lamps then take 2,000 ampères and 100 volts; but this does not amount to more than 66,000 watts, as the current is not in step with the electromotive force. The dynamos thus have to supply 2,000 volts and 100 ampères; whereas the same power, if the current did not lag, would be supplied with 2,000 volts and 33 ampères. This gives rise to several troubles. Suppose each machine has an armature wound to give 2,000 volts and 33 ampères, or 66,000 watts, it takes three instead of one to work the lamps. In addition to this, the lagging of the current weakens the field of the dynamos, so that they need more excitation to give 2,000 volts than they would need even on full load on a non-inductive resistance. Moreover, running three engines and dynamos at a third load instead of one at full load is not economical. A condenser takes a current which leads relatively to the pressure, so that it counteracts the effect of the lagging current. The 100 ampères may be regarded as compounded of 33 ampères in step with the pressure, and 95 ampères lagging a quarter of a period. A condenser of about 85 microfarads will supply the 95-ampère component, while one dynamo supplies the 33 ampères really needed by the lamps. This reasoning holds good without the curve of sines assumption.

The use of condensers to overcome troubles arising from exciting or magnetizing currents of closed or open circuit transformers has already been mentioned.

They may also be used to increase the output of dynamos. As already explained, even if a dynamo is worked on resistance, the cross induction causes the current to lag, and the back induction weakens the field. If a condenser is put in shunt to the terminals of the machine, its current strengthens the field again and increases the terminal pressure, and therefore the output. If the condenser is large enough, and if the armature actions are great enough it might be possible to make a machine excite itself without any field winding at all. This action of a condenser on a dynamo may be equally easily explained on the self-induction theory. The difference between the two theories may be shown here, however. According to the self-induction theory, if the condenser is large enough to produce resonance—that is to say, when $(2\pi n)^2 L K = 1$—the output increases till the current is as great as if the no-load pressure of the machine were short-circuited on the armature resistance. According to the armature reaction theory, the machine increases its field till the field magnets become more saturated; in fact, the machine is like a direct-current shunt-wound dynamo which has a low-resistance shunt. I do not wish to go into this matter further here, for it might lead to a discussion of a rise in the Deptford mains—a subject which will be treated, I am informed, in a forthcoming paper, and will certainly receive full justice at the hands of the authors.

The commercial manufacture of high-pressure condensers is not so easy as might be supposed. Knowing the difficulties there are in insulating leads and mains—in which thick insulation is permissible, and, in fact, advisable—it may be realized that to insulate many hundreds of square feet of metallic surface with the thinnest possible material is anything but an easy problem. In addition to being a good insulator, the dielectric must be free from "absorption." Some account of my work on condensers has lately been given.* Mr. W. F. Bourne, who has carried out all the experiments, has tried almost every conceivable kind of dielectric, and finds a kind of paper called "butter-skin," soaked in paraffine oil, the best material. It is curious that this particular kind of paper is specially made so as to be grease-proof. Some kinds of bank post paper worked nearly as well, but it is too expensive for commercial use. It seems as if the paper must be relied upon for insulation, not the paraffine. The condensers are simple cast-iron boxes containing numbers of sheets of paper and tinfoil. Lids are fitted on and made tight.

Phil. Mag., February, 1891.

TOWN LIGHTING.

Alternate arc lamps have already been discussed to some extent. In some places, especially in small towns, it is usual to have special circuits for the town lighting which are shut off during the day. It is needless to point out that, if the low-pressure network is used, condensers at the station allow arc lamps to be run with choking coils, and incandescent lamps can be run direct, and it is no more necessary to run special mains for the street lighting than it is needful to put down two sets of gas pipes in a town. Sometimes, however, high pressure mains are used. Each arc lamp can then have its own constant-current transformer. If incandescent lamps are used, the plan generally adopted is using a transformer for every 10 or 20 lamps. If the wires are underground, this involves great expense; and if overhead, it means both expense and unsightliness. A small "hedgehog" transformer has been designed to meet this particular want. It is so small that it can be worked into the design of the lamp-holder or shade, and one can be used for each lamp.

In America alternating arc lamps are run in series, with a series transformer for each. This arrangement is quite unnecessary for places where there is incandescent lighting too. It has the advantage of allowing series arcs without bringing high pressures into the lamps. It has no other advantage over direct series lighting. The dynamo used by the Westinghouse Company is made to give nearly constant current. This is a barbarous arrangement. It is a reversion to the old alternating machines of 10 years ago, which gave approximately constant current. All that is needed is great armature reaction, and hence a large machine for the output. The economical way of getting constant current is to use a good dynamo, and to take the governor off the engine, or to use it as a safeguard against racing only. If the Westinghouse machine has only quarter load on, it still goes at full speed, using nearly full steam, and wearing everything out. With a constant-pressure dynamo it would run at quarter speed, each cylinderful of steam being used economically and being expanded properly. To put a constant-speed governor on the engine, and then to design a special dynamo to get over the difficulties you have introduced, is a very common proceeding with direct-current arcs also.

Alternating constant currents have, however, one advantage over direct that I think is not realized. Synchronizing motors will run perfectly on series constant-current circuits; and as they run at constant speed, there is no racing, or trouble about governing, as in the case of direct currents. Of course, constant speed of engine is here necessary to give constant frequency. Many people seem to have gathered from Dr. Hopkinson's paper that series alternating motors will not run; but this is a false inference.

Phenomena of Alternating Currents of Very High Frequency.

BY NIKOLA TESLA.

I cannot pass without comment the note of Prof. Thomson in THE ELECTRICAL WORLD of April 4, although I dislike very much to engage in a prolonged controversy. I would gladly let Prof. Thomson have the last word, were it not that some of his statements render a reply from me necessary.

I did not mean to imply that whatever work Prof. Thomson has done in alternating currents of very high frequency was subsequent to his letter published in *The Electrician*. I thought it possible, and even probable, that he had made his experiments some time before, and my statement in regard to this was meant in this general way. It is more than probable that quite a number of experimenters have built such machines and observed effects similar to those described by Prof. Thomson. It is doubtful, however, whether, in the absence of any publication on this subject, the luminous phenomena described by me have been observed by others, the more so as very few would be likely to go to the trouble I did, and I would myself not have done so had I not had an advance of firm conviction gained from the study of the works of the most advanced thinkers that I would obtain the results sought for. Now that I have indicated the direction, many will probably follow, and for this very purpose I have shown some of the results I have reached.

Prof. Thomson states decisively in regard to the experiment with the incandescent lamp bulb and the filament mounted on a single wire that he cannot agree with me at all that conduction through the glass has anything to do with the phenomenon observed. He mentions the well-known fact that an incandescent lamp acts as a Leyden jar and says that "if conduction through the glass were a possibility this action could not occur." I think I may confidently assert that very few electricians will share this view. For the possibility of the condenser effect taking place it is only necessary that the rate at which the charges can equalize through the glass by conduction should be somewhat below the rate at which they are so stored.

Prof. Thomson seems to think that conduction through the glass is an impossibility. Has he then never measured insulation resistance, and has he then not measured it by means of a conduction current? Does he think that there *is* such a thing as a perfect non-conductor among the bodies we are able to perceive? Does he *not* think that as regards conductivity there can be question only of degree? If glass were a perfect non-conductor, how could we account for the conduction through a glass condenser when subjected to steady differences of potential?

While not directly connected with the present controversy I would here point out that there exists a popular error in regard to the properties of dielectric bodies. Many electricians frequently confound the theoretical dielectric of Maxwell with the dielectric bodies in use. They do not stop to think that the only perfect dielectric is ether, and that all other bodies, the existence of which is known to us, must be conductors, judging from their physical properties.

My statement that conduction is concerned to some, although perhaps negligible, extent in the experiment above described was, however, made not only on account of the fact that all bodies conduct more or less, but principally on account of the heating of the glass during the experiment. Prof. Thomson seems to overlook the fact that the insulating power of glass diminishes enormously with the increase in temperature, so much so that melted glass is comparatively an excellent conductor. I have, moreover, stated in my first reply to Prof. Thomson in THE ELECTRICAL WORLD of March 21, 1891, that the same experiment can be performed by means of an unvarying difference of potential. In this case it must be assumed that some such process as conduction through the glass takes place, and all the more as it is possible to show by experiment that with a sufficiently high steady difference of potential enough current can be passed through the glass of a condenser with mercury coatings to light up a Geissler tube joined in series with the condenser. When the potential is alternating the condenser action comes in, and conduction becomes insignificant, and the more so the greater the rate of alternation or change per unit of time. Nevertheless, in my opinion, conduction must always exist, especially if the glass is hot, although it may be negligible with very high frequencies.

Prof. Thomson states further that, from his point of view, I have misunderstood his statement about the limit of audition. He says that 10,000 to 20,000 alternations correspond to 5,000 to 10,000 complete waves of sound. In my first reply to Prof. Thomson's remarks (in THE ELECTRICAL WORLD of March 21, 1891) I avoided pointing out directly that Prof. Thomson was mistaken, but now I see no way out of it. Prof. Thomson will pardon me if I call his attention to the fact he seems to disregard, namely, that 10,000 to 20,000 alternations of current in an arc—which was the subject under discussion—does not mean 5,000 to 10,000, but 10,000 to 20,000 *complete waves of sound*.

He says that I have adopted or suggested as the limit of audition 10,000 waves per second; but I have neither adopted nor suggested it. Prof. Thomson states that I have been working with 5,000 to 10,000 complete waves, while I have nowhere made any such statement. He says that this would be working below the limit of audition, and cites as an argument that at the Central High School in Philadelphia he has heard 20,000 waves per second; but he wholly overlooks a point on which I have dwelt at some length—namely, that the limit of audition of an arc is something entirely different from the limit of audition in general.

Prof. Thomson further states, in reply to some of my views expressed in regard to the constant current machines, that five or six years ago it occurred to him to try the construction of a dynamo for constant current, in which "the armature coils were of a highly efficient type, that is, of comparatively short wire length for the voltage and moving in a dense magnetic field." Exteriorly to the coils and to the field he had placed in the circuit of each coil an impedance coil which consisted of an iron core wound with a considerable length of wire and connected directly in circuit with the armature coil. He thus obtained, he thought, "the property of considerable self-induction along with efficient current generation." Prof. Thomson says he expected "that possibly the effects would be very much the same as those obtainable from the regularly constructed apparatus." But he was *disappointed*, he adds. With all the consideration due to Prof. Thomson I would say that to expect a good result from such a combination was rather sanguine. Earth is not farther from Heaven than this arrangement is from one in which there would be a length of wire sufficient to give the same self-induction wound on the armature and utilized to produce useful E. M. F. instead of doing just the opposite, let alone the loss in the iron cores. But it is, of course, only fair to remember that this experiment was performed five or six years ago, when even the foremost electricians lacked the necessary information in these and other matters.

Prof. Thomson seems to think that self-induction wipes out the periodical undulations of current. Now self-induction does not produce any such affect, but, if anything,

it renders the undulations more pronounced. This is self-evident. Let us insert a self-induction coil in a circuit traversed by an undulating current and see what happens. During the period of the greatest rate of change when the current has a small value, the self-induction opposes more than during the time of the small rate of change and when the current is at or near its maximum value. The consequence is that with the same frequency the maximum value of the current becomes the greater, the greater the self-induction. As the sound in a telephone depends only on the maximum value it is clear that self-induction is the very thing required in a telephone circuit. The larger the self-induction the louder and clearer the speech, provided the same current is passed through the circuit. I have had ample opportunity to study this subject during my telephone experience of several years. As regards the fact that a self-induction coil in series with a telephone diminishes the loudness of the sound, Prof. Thomson seems to overlook that this effect is wholly due to the impedance of the coil, *i. e.*, to its virtue of diminishing the *current's strength*. But while the current's s rength is diminished the undulation is rendered only more pronounced. Obviously, when comparisons are made they must be made with the same current.

In an arc machine such as that of Prof. Thomson's the effect is different. There one has to deal with a make and break. There are then two induced currents, one in the opposite the other in the same direction with the main current. If the function of the mechanism be the same, whether self-induction coil be present or not, the undulations could not possibly be wiped out. But Prof. Thomson seems likewise to forget that the effect is wholly due to the defect of the commutator; namely, the induced current of break—which is of the same direction with the main current and of great intensity when large self-induction is present—simply bridges the adjacent commutator segments, or if not entirely so, at least shortens the interval during which the circuit is open and thus reduces the undulation.

In regard to the improvement in the feeding of the lamps by vibration or undulations, Prof. Thomson expresses a decisive opinion. He now says that the vibrations *must* improve the feeding of a clockwork lamp. He says that I "contented myself by simply saying" that I cannot agree with him on that point.

Now, *saying it* is not the only thing I did. I have passed many a night watching a lamp feed, and I leave it to any skilled experimenter to investigate whether my statements are correct. My opinion is that a clockwork lamp—that is, a lamp in which the descent of the carbon is regulated not by a clutch or friction mechanism, but by an escapement—cannot feed any more perfectly than tooth by tooth, which may be a movement of, say, one-sixty-fourth of an inch or less. Such a lamp will feed in nearly the same manner, whether the current be perfectly smooth or undulating, provided the conditions of the circuit are otherwise stable. If there is any advantage I think it would be in the use of a smooth current, for with an undulating current the lamp is likely to miss some time and feed by more than one tooth. But in a lamp in which the descent of the carbon is regulated by friction mechanism, an undulating current of the proper number of undulations per second will always give a better result. Of course to realize fully the benefits of the undulating current the release ought to be effected independently of the up and down movement, as I have pointed out before.

In regard to the physiological effects Prof. Thomson says that in such a comparatively poor conductive material as animal tissue the distribution of current cannot be governed by self-induction to any appreciable extent, but he does not consider the two-fold effect of the large cross-section pointed out by Sir William Thomson. As the resistance of the body to such currents is low, we must assume either condenser action or induction of currents in the body.

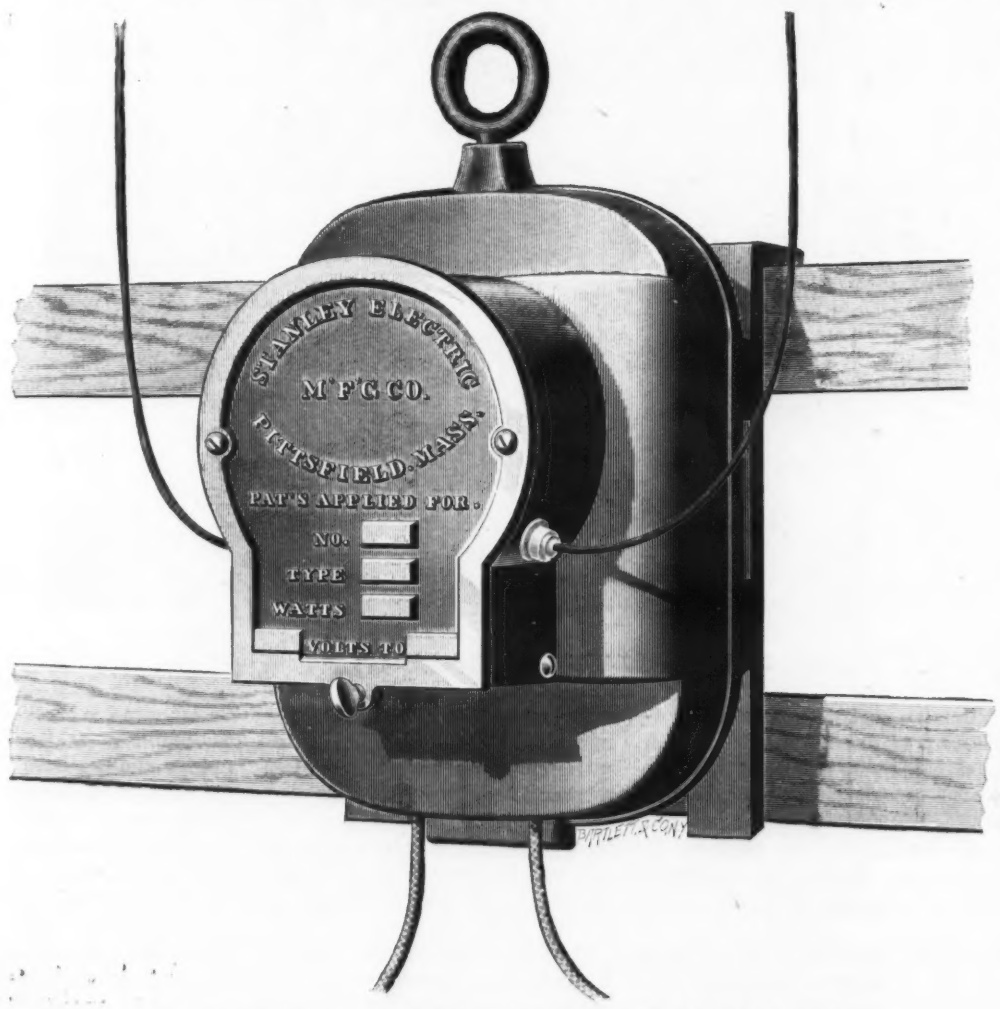


FIG. 1.—STANLEY ALTERNATING CURRENT TRANSFORMER.

The Stanley Transformer.

As alternating current apparatus has come into more and more general use it has gone through the same stages of evolution as has characterized direct current machines. The component parts of the system have been worked out more and more carefully, and more efficient types of the machines designed. It has taken some years of experiment to bring the alternating dynamo to its present high state of efficiency, and the other necessary part of the alternating system, that is, the secondary generator—the transformer — has gone through somewhat the same slow process of evolution. In the early stages of the art the transformer was inefficient and regulated badly. It was improperly designed and often poorly built. Gradually the principles involved in its construction came to be understood, the parts were better proportioned to serve their purpose, and a far better quality of iron was used for the core.

We give on the present page two cuts of the very latest type of transformer. It is manufactured by the Stanley Mfg. Company from the designs of Mr. William Stanley, Jr., who has become so widely known through his connection with the rise and development of the Westinghouse system. Many of the fundamental patents of this company are the fruits of Mr. Stanley's inventive genius. In the transformer that he has just designed and put on the market there are no radical changes from existing types; it is the result of straightforward, earnest effort to make a thoroughly efficient, reliable and well constructed instrument. It is built for standard voltages and frequencies, to work on any system, and is placed upon the market on its merits. The design is very carefully worked out, and especially is the most extreme pains taken to obtain the best possible iron for the core. The result of this policy is evident in the tests that have been made of the finished product by Mr. Stanley, and which we have every reason to believe are correct. The efficiency for a 20-light transformer at full load is 94.3 per cent. The variation of electromotive force in the secondary is but 1.9 per cent. the leakage current but a twentieth of an ampère, while 12 watts of useful energy is secured per pound weight of the transformer. These results, considering the small size of the transformer tested, are satisfactory in the highest degree. In the method of winding employed particular pains was taken to avoid the chance of a cross between the primary and secondary coils, and a special insulating compound was developed to bring the insulation between the coils up to the highest practicable point. Of course all these precautions tend toward safety. Among minor practical details the arrangement of the fuses, shown in Fig. 2, is worth more than a passing notice. No secondary fuse at all is employed, inasmuch as a fusible cut-out is always inserted elsewhere in the secondary circuit. The primary fuse wire is carried on a porcelain block or plug and can be secured in place with great ease and rapidity. To replace a fuse which burns out it is only necessary to open the door in the front of the transformer by turning a thumbscrew, remove the plug, insert another and then close up the case again. Or, if desirable, a new fuse can be attached, and the same plug replaced. All sizes of transformers up to 100 lamps have interchangeable fuse plugs. It is worth noticing that it is not necessary to remove the whole front of the transformer to replace a fuse plug—merely dropping the door in the front, as shown in the cut—and no screw driver or other tools are required.

FIG. 2.—STANLEY ALTERNATING CURRENT TRANSFORMER.

Altogether there are many good points about this Stanley transformer, and not the least of them is that it is put on the market unconnected with any system, and unhampered by any peculiarities that compel its use in connection with other appliances. Most companies operating stations are in a position to make an intelligent choice in their selection of apparatus, and oftentimes the best results are obtained by building up a system in accordance with the particular needs of the place without rigid adherence to any one manufacturer.

Annual Report of the American Bell Telephone Company.

The annual report of the American Bell Telephone Company, for the year ending Dec. 31, 1890, shows as follows:

Earnings.	1890.	1889.
Rental of telephones	$2,913,368.63	$2,657,361.90
Dividends	1,256,274.19	1,230,560.33
Extra territorial and branch lines	89,478.12	82,556.63
Telegraph commission	26,491.60	22,367.02
Interest	77,447.89	43,964.44
Miscellaneous	12,220.44	7,954.19
	$4,375,290.88	$4,044,704.71
Expenses.		
Operation	$311,437.98	$769,493.37
Legal	123,359.08	144,56b.62
Interest and taxes	257,174.85	225,199.97
Commission	575,221.03	511,215.31
Royalty	10,000.00	10,500.00
Concessions	228,573.94	221,288.11
Miscellaneous	105.65	3,702.64
	$1,505,872.53	$1,385,966.02
Net earnings	$2,869,418.35	$2,658,738 69

Comparative results may be presented thus:

	1890.	1889.	1888.
Gross earnings	$4,375,291	$4,044,705	$3,865,118
Expenses	1,505,873	1,385,966	1,450,913
Net earnings	$2,869,418	$2,658,739	$2,414,205
Miscellaneous		3,150	22,258
Total net	$2,869,418	$2,661 889	$2 436,463
Dividends, 18 per cent	2,213,913	1,838,913	1,789,878
Surplus	$655,505	$822,976	$646 585
Reserve for general depreciation	600,000	600,000	600.000
Balance	$55.505	$222,976	$46.585
Reserve, depreciation instruments	55,505	100,000	46,585
Net surplus		$122.976	
Surplus ac. Dec. 31	$2,151,012	2,151,012	$2,028,036

Ledger balances Dec. 31, 1890, were as follows:

DEBTORS.		
Telephones	$919,274 94	
Real estate	744,333.00	
Stocks	32,740.580 03	
Merchandise and machinery	9,932.94	
Bills and accounts receivable	2,034,289.02	
Cash and deposits	187,935.39	
CREDITORS.		
Capital stock		$12,500,000.00
Debenture bonds, 1888		2,0 0,000.00
*Bills and accounts payable		1.334,636 14
Patent account (profit and loss)		10.516,544.96
Profit and loss		5,545,131.11
Reserve		2,489,012.50
Surplus		2,151.011.61
	$38 636.336.32	$36,636,336.32

* Of this amount, $375.000 is the dividend payable Jan. 15, 1891, to stockholders of record Dec. 31, 1890.

Compared with 1889, the changes shown in the above are these: Debtors—Telephones increased, $92,062.74; real estate, $271,571.29; stocks, $4,591 219; merchandise and machinery decreased, $3,016.62; bills and accounts receivable increased. $545,569.75, and cash and deposits decreased, $865,852.76. Creditors—Capital stock increased, $696,100; bills and accounts payable increased, $781,122.54; patent account, $84.182.60; profit and loss, $1,901,368.18; and reserve, $666,679.99. The balance of debtors and creditors increased, $4,631,553,31.

The report shows that Dec. 31, 1890, there were total miles of wire, 240,412; increase, 47,199; total circuits, 173,665; increase, 16,885; total employés, 7,845; increase, 1,087; total stations, 202,931; increase, 17,928, of which 2,746 are toll stations, not at fixed annual rates, not heretofore classed with subscribers' stations; total instruments in hands of licensees under rental Dec. 20, 1890, 483,790; increase, 38,929. The estimated number of exchange connections daily in the United States is 1,438.294, or a total per year of over 450,000,000. The average daily number of extra territorial connections is 9,701, or a total per year of about 3,200,000. Extra territorial earnings for the year amounted to $1,116,975.18, of which the Bell Company's share is $91,261.17, an increase of $7,027.99 over 1889. A material increase in mileage of underground wire was made, equal to 27,573, which gain is more than the total mileage a year ago. Twenty-one places now have underground wires, against thirteen a year ago.

The long distance company added 4,682 miles of wire to its total, and is earning a moderate rate on the investment above its expenses. The net earnings last year amounted to $120,665, which were invested in extension of the plant.

Electrical Progress in Sweden.

The new catalogue of the General Telephone Company in Stockholm, with 240,000 inhabitants, has recently been issued. It contains 600 pages, and gives a list of 6,254 separate telephones in use. Last year saw an increase of 719 subscribers, of which 125 have metallic circuits allowing them to correspond on the long interurban lines, stretched all over the country by the government and the above company. The correspondence during 1890 amounted to 12,000,000 connections. Besides the grand central exchange in the capital the company has in operation 36 small stations in the surrounding country.

With the beginning of this year the company, which was founded on the Wenstrom dynamo patent in Sweden, was transformed into a General Electric Company, the headquarters of which will be at Westeras, an ancient town not far from the capital and well situated on Lake Mater and on the railroad running west from Stockholm. The resources in capital as well as manufacturing facilities had proved to be insufficient for the increasing work to be done, but now ample capital and manufacturing facilities are to be had. The new works are now under construction in the above named town on a site conveniently located close to the railway station and to the pier. Thus the communications are excellent, both on land and water. The works will consist of a large factory building, with all modern improvements, a smaller building for auxiliary steam plant, forge and metal foundry, a large store house and an office building with apartments on the second floor. The power will be taken from a waterfall in another part of the town and transmitted electrically.

The South Side Station of the Chicago Edison Company.

The following remark of Mr. W. L. Church, superintendent of the Chicago Edison Company, is taken from the issue of THE ELECTRICAL WORLD of Oct. 5, 1889: "There is a great demand for electric lights for domestic purposes in Chicago, and the time will come, and soon, when we shall have them. The company is now considering the erection of power stations on the South and North sides for the purpose of supplying currents to the residents."

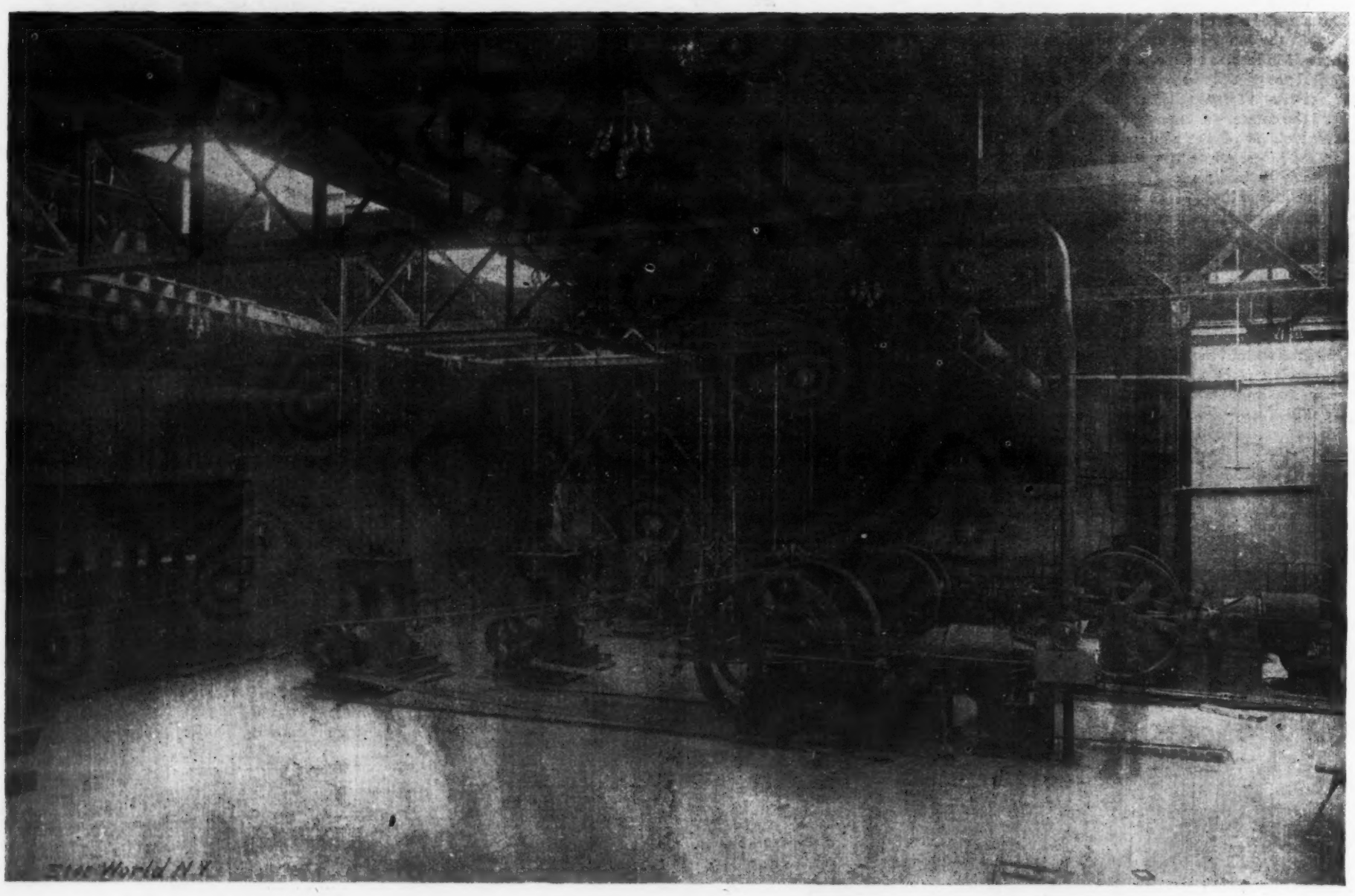
Of these two projected sub-stations the one on the South side is an established fact, having furnished current for the first time April 1. This station is located on the corner of Wabash avenue and 27th street. Situated as it is in close proximity to a section of the city noted for its beautiful residences, it opens a field which will doubtless prove to be extensive and profitable. The building is of red pressed brick on cut stone foundation, and contains, in addition to the engine, dynamo and boiler rooms, the various offices, store rooms and meter rooms which are necessary.

The steam equipment consists of two Heine boilers having a nominal capacity of 375 h. p. each, but which can, however, be safely increased to between 550 and 600 h. p. each, owing to the high pressure which will be used, 135 pounds.

The motive power is furnished by three McIntosh & Seymour compound condensing high-speed engines of a total capacity of 550 h. p. The feed water is heated by a 550 h p. Berryman heater, and is circulated by Worthington pumps.

The electrical equipment is composed of four No. 32 Edison generators and two No. 20 generators of the same type, making a total capacity for the station of 7,000 16 c. p. lamps. The company has, at the present date, approximately, 12,000 lamps distributed through 15¼ miles of feeders, laid in conduits of the usual Edison pattern. Current will be supplied continuously.

The large switchboard shown in the illustration presents a remarkably handsome appearance with the highly polished copper rods and switches, and the shining wood work as a background. The bus bars are all rectangular and are mounted upon special cleats. The various indicators for each circuit are separately mounted upon a switchboard of their own, so that the attendant in charge is able to detect any variation in the lights on any circuit. The engine and dynamo room is shown in the illustration on this page.



ENGINE AND DYNAMO ROOM OF THE SOUTH SIDE EDISON CENTRAL STATION IN CHICAGO.

A Local Telegraph Company.

At Richmond, Ind., a city containing about 20,000 inhabitants, there exists a telegraph organization known as the Richmond Local Telegraph Company. The organization is composed of amateur telegraphers, and its object is to secure a means of frequent communication and social enjoyment for its members. Its officers receive no compensation for their services, and the fees charged cover only the actual expenses involved. This private telegraph line has now been in operation some five years, and has proven a fruitful source of amusement and recreation as well as instruction to the members of the company, several of whom are now occupying good positions secured through the practical knowledge gained in the operation of the private line.

The total length of the line is between four and five miles, and extends from one end of the town to the other, in a somewhat irregular course. The members of this small company have endeavored to make the line more substantial and permanent in its character than the average private line, and are very proud of the result. They have issued a blue print map of the city, showing the location of the line, with each of the 26 stations which it reaches, together with the names of the members, and the call of each one.

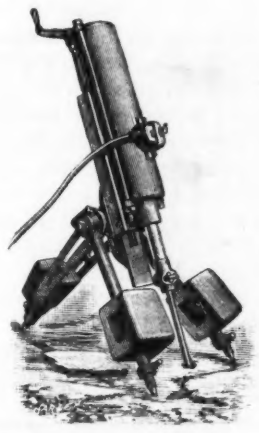
The supervision of the financial, mechanical and electrical details of construction and maintenance of the line is intrusted to the board of directors, at present composed of four members. Each subscriber is expected to keep his own instruments in proper order, but beyond that is not concerned with the care of the line. The battery, line wire and materials are the property of the company, the office connections and instruments belonging to the individual members. The average cost of an office installation, as shown by experience, is not greater than $6. An admission fee of $2 is charged to cover the cost of necessary additional battery, and a regular monthly fee of 25 cents is assessed to meet the expense of maintaining the line and battery. This enterprise is a very commendable one, and, as might be expected, all the members are interested to some extent in the general progress of electrical applications outside of the field of telegraphy. Mr. O. E. McMeans is president of the company at the present time, and Mr. A. B. Price is its secretary and treasurer.

Trial of the Edison Electric Drill.

The Edison General Electric Company gave an exhibition of its electric percussion drill on Friday of last week in Quincy, Mass., which was attended by a large number of quarry owners from different quarries in the State, as well as by a large number of mine owners from Boston and elsewhere.

The result of the exhibition was very satisfactory indeed, and the general opinion expressed by parties well versed in such matters was that the electric percussion drill is far ahead of the steam or compressed air drill. Two steam drills working in the same quarry gave an excellent chance for comparison. Although the stone in Quincy is exceptionally hard, the electric drill was able to drill a hole 1¼ inches in diameter at an average rate of 2¼ inches per minute, with an expenditure of less than four h. p. delivered to the generator. At one time the rate of drilling was as high as four inches per minute.

Among the special features brought out by this exhibition were the extreme ease with which the power could be transmitted to the drill from the generating station, and the great simplicity of the machine itself. The wires were taken from the edge of the quarry direct to the



EDISON ELECTRIC DRILL.

place where the drill was at work, without any further intermediate supports being needed. The distance along the wires was 350 feet; the vertical distance between the drill and the edge of the quarry, 100 feet.

For the purpose of exhibiting the ease with which the machine could be taken to pieces, and the defective parts replaced by others held in reserve, the drill was several times opened and entirely taken apart, the time required for this being less than three-quarters of an hour. It must be borne in mind that to do the same thing with a steam or compressed-air drill would require a very much longer time, owing to the fact that the different parts have to fit well together, and the joints have to be well packed. In case of accident to the last-mentioned drills, they would have to be repaired by a competent mechanic, and it would be some time before they could again be used; whereas, with the electric drill it was shown that any accident to one or the other of its parts could be remedied within three-quarters of an hour by simply taking out a defective part and dropping in another one held in reserve, as the parts of the electric drill are made according to standard sizes and are interchangeable. The field for this class of apparatus is enormous, and the Edison company already has orders on hand for a great many plants, and is rapidly increasing the force employed upon this class of work.

The Electrix Key Socket.

We illustrate herewith the new key socket just being introduced by the Star Electrix Company of Philadelphia. This socket is an improvement on the well known "Electrix" socket, and is made to fit all lamps. The interio body portion is made in a single piece of porcelain, which can be readily removed from the shell when it is desired to wire the socket on a fixture.

STAR ELECTRIX KEY SOCKET.

The Westinghouse Automatic Circuit Breaker.

Street railway men who have operated street cars, and have used in their station the ordinary fusible block and the make-and-break switch, know how difficult it is to keep

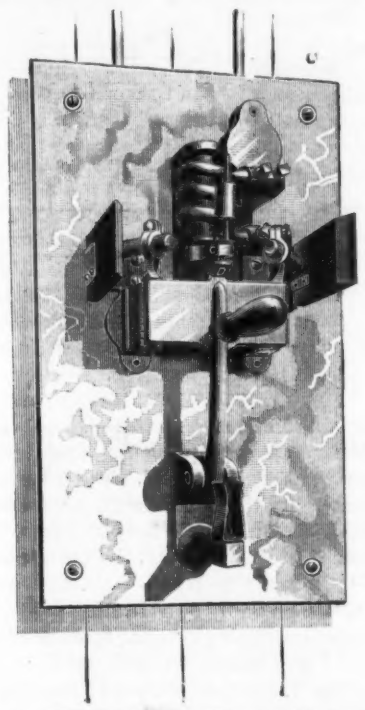


FIG. 2.—WESTINGHOUSE CIRCUIT BREAKER.

their switchboard looking well, especially when they have had a number of short circuits on the line. Not only are the safety fuse blocks burned and discolored, but also the portion of the switchboard near the safety fuse is injured, and in addition to the above the jaws of the switch are partly melted or fused, and the whole presents anything but a neat appearance.

In order to avoid this, the Westinghouse Electric and Manufacturing Company has devised an automatic circuit breaker which breaks the current automatically whenever there is a short circuit on the line, without burning or in any way disfiguring the breaker itself. It has been tested on as high a current as 900 ampères and 500 volts, or a total of 450,000 watts, without in any way affecting or burning the breaker. It is intended that there should be one of these automatic breakers upon each feeder.

In the accompanying cuts Fig. 1 is a view of the breaker when open, and Fig. 2 represents it closed. The instrument consists of an electromagnet *A* in series with a double break switch—*B*, B^1 and B^2. If a short circuit occurs in the line, the electromagnet will attract its armature *C*, and with it the trigger *D*, which holds the switch closed, and thereby allows the spring *E* to throw the lever arm out of the contacts. This, however, does not yet open the circuit, as the carbon contacts *F* and F^1 carried by the lever arm still touch the carbon plates *G* and G^1, at the sides of the switch, and at these carbon points the circuit is finally broken without injuring in the least the metal parts of the switch. The feeder switch should always be opened before the circuit breaker is closed again.

The point at which these circuit breakers will cut out can be regulated by changing the weight *H*, attached to the armature. The Westinghouse Electric and Manufacturing Company makes two styles of circuit breakers, viz.: one to work on feeders up to 400 ampères capacity and one to work on feeders from 400 ampères to 800 ampères capacity. These can be used in connection with any street railway system.

The Westinghouse "Ironclad Gearless" Railway Motor.

The single reduction motor lately put on the market by the Westinghouse Electric and Manufacturing Company has given such excellent results that this company has decided to go a step further and build a direct-acting gearless railway motor. Two of these motors have been built in the Pittsburgh factory, and, after careful tests, have been found to exceed the most sanguine expectations. The figure shows a view of the motor mounted on the car axle.

This motor the Westinghouse Company has termed the "ironclad gearless," for, as will be seen, it is completely surrounded and protected by the field frame, which forms a casing of sufficient strength to withstand all shocks and obstructions of the roadbed. The field consists of two

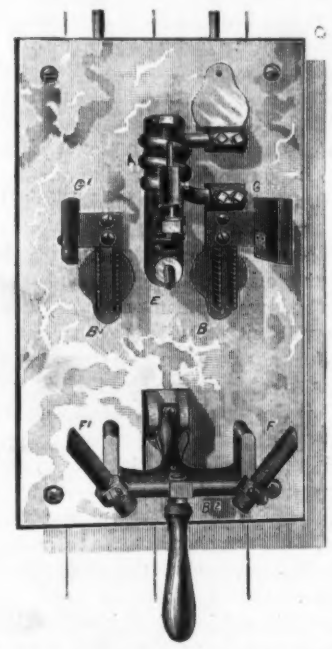


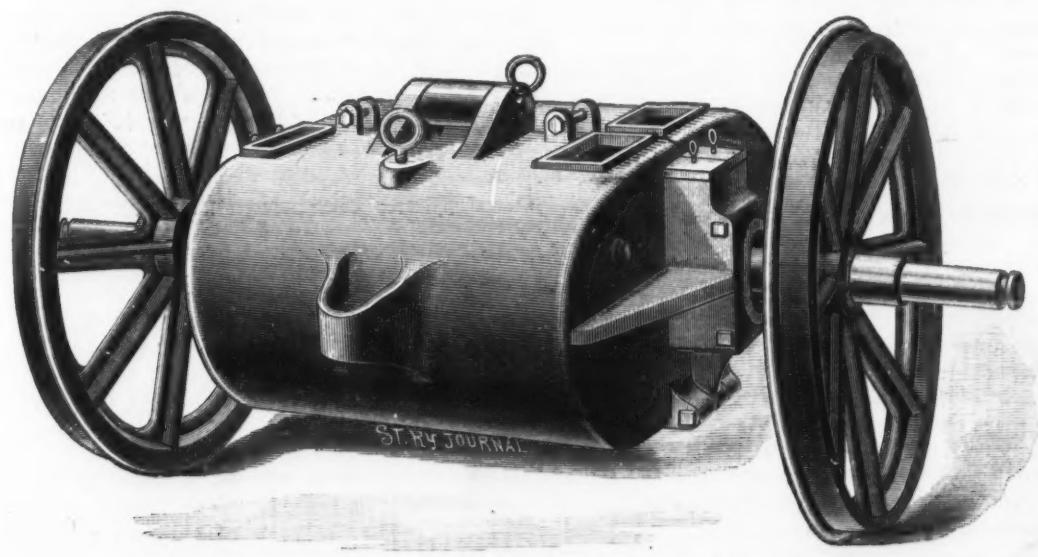
FIG. 1.—WESTINGHOUSE CIRCUIT BREAKER.

symmetrical castings of special iron, sleeved upon the armature shaft or axle, hinged on top and secured together by bolts. The joints are made watertight, and the bearings are provided with leather cups for the same purpose, which makes it dust-proof.

The armature, which is of the drum type, is built upon the car axle. The sheet iron discs, being solid and keyed to the axle, give the axle an additional strength, which precludes any possibility of its bending. This arrangement, of course, eliminates all gearing. The car wheels are fastened to the shaft by a new arrangement, which makes it possible to replace them easily and quickly without any special tools or skilled labor. The armature is but 16 inches in diameter, with a grooved periphery for the wires, which not only increases the efficiency, but holds the wires rigid. It is securely fastened to the shaft, and connections with the armature are made by short, heavy wires. The brush-holder, which is rigidly fastened to the magnet-frame, is of very simple design, well insulated and easily accessible by openings provided with watertight lids.

The weight of the magnet-frame is counterbalanced and cushioned upon powerful spiral springs which rest upon the cross bars of the truck. These springs prevent the field from rotating, and give the motor the necessary flexibility for easy starting. The total depth of the motor is but 20 inches, giving 5 inches clearance between the bottom of the motor and the rail, with a 30-inch wheel.

The Westinghouse Company claims for its "ironclad gearless" a high efficiency, actual tests having shown a working efficiency of 90 per cent. It is also claimed that, after two hours' run with a load of over 20 h. p. the rise in the temperature of the armature and field coils was onl 30° C. above the surrounding air.



WESTINGHOUSE GEARLESS STREET RAILWAY MOTOR.

Inductive Disturbances in Telephone Circuits.

After the reading of a paper on the above subject by Mr. J. J. Carty,* the following interesting discussion took place:

Mr. A. E. Kennelly: Mr. President and gentlemen, the very interesting experiments we have just heard described can leave no doubts in the minds of any of us that electrostatic induction has a very important influence in disturbance between parallel telephonic lines, and assuming that the experiments are truly represented—and I am far from desiring to impugn them—there can be no question that electrostatic capacity is chargeable with all, or nearly all, the disturbance that was occasioned in them under those conditions. But the general question of mutual disturbance between telegraphic or telephonic conductors is a very broad and a very vexed one. If two wires run parallel to each other and current flow through one, we must have electromagnetic disturbance. This was one of Faraday's original experiments, and we must also have electrostatic disturbance. The question is whether we are entitled to calculate upon what proportion of the disturbance is due to one and what to the other. In this case, as in so many others, the question of jurisdiction arises. It is sometimes asked, have we sufficient knowledge of the laws of nature in this particular instance to rely upon the results of calculation, and the answer is, apparently, that we have. Because, however limited our knowledge of the laws of nature may be, it seems to be, in this instance, sufficiently perfect to answer the purposes of the inquiry. Just as when we let a stone fall to the ground, if any one were to ask us if we had the right to predict by calculation what the result of that fall would be, we could say that to a certain degree of accuracy we could certainly do so by treating the stone as a rigid body, and the laws of rigid bodies are simple and comparatively well understood. But if we had to undertake to say exactly what the conditions would be, then we should have to come to the molecule, and our knowledge of the molecule is at present rather indefinite.

The theory of this subject has been treated by several writers from time to time to time, and particularly it has

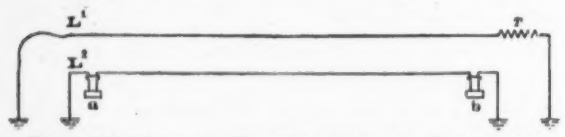


Fig. 12.—Carty's Experiments on Induction Interference.

been very ably treated by Oliver Heaviside in the *Journal of the Society of Electrical Engineers* of London, in the February number, 1881.

I have endeavored to obtain some quantitative notion of how much electrostatic disturbance and how much electromagnetic disturbance would take place in Mr. Carty's Fig. 2, by assuming certain definite quantitative relations between those circuits. We suppose that L^1 and L^2 are half an inch apart, and all wires are No. 12 B. & S. gauge copper, also that L^3 is so far remote that its inductive influence on the others and the influence of the others upon it may be omitted from the calculation. Then it is easy to find out how much electrostatic induction there would be, supposing electromagnetic action absent, and how much electromagnetic action takes place between the two, supposing electrostatic disturbance did not take place. To avoid very great complexities which would take long to follow out to their ultimate consequences, that perhaps is a fair comparison. Under those circumstances, supposing that electrostatic influence existed alone and then afterward electromagnetic influence existed alone, with four telephones in the secondary circuit, whose resistance, we might suppose, would be 75 ohms each, and whose inductance might be 90 milli-henrys apiece; then if the primary circuit had a periodic electromotive force acting upon it, such as would correspond for example to the note *A* sounded in the telephone at 400, or more accurately, 435 periods per second, it would be necessary to insert an impedance in the primary circuit equal to 400 ohms in order to have electromagnetic action equal to electrostatic action. The fact Mr. Carty has mentioned, that the impedance of the receiving instrument of the primary circuit was high, leads us to suppose that this impedance was much greater, probably 10 times as great, and would bear out his statement from the theoretical point of view that the effect of electromagnetic disturbance is virtually null compared with electrostatic disturbance under those conditions. But it would be desirable if Mr. Carty could give us an idea as to how far reducing the impedance in the receiving end disturbed the neutral point, and so gave indications of a tendency to equality between the two disturbances.

Of course, the rough calculation that I have just presented deals with the subject, ignoring entirely all those waves and oscillations which we know must inevitably pursue their path in primary circuits upon any change of current. We are all familiar with the simple and very interesting experiment of taking the ropes from a flagstaff, say, or the halyards of a mast when they are tolerably heavy—taking them in the hand and giving them a jerk. Of course, the ultimate tendency of the displacement of the ends held in the hand would be to cause the rope to assume a slightly different catenary, but the immediate consequence is that a wave travels up the rope, reaches the top, is reflected back and again comes to the hand, subsiding gradually all the time. It may even be sufficiently strong to leave the hand again and repeat its course back to the top. But that represents very faithfully the motion that takes place in any electric circuit when the primary electromotive force is impressed upon it. No matter what the conditions may be of electrostatic induction or electromagnetic induction, so long as both are present, no current can be started in the wire, with any finite change of electromotive force, without setting up an oscillation or a wave in that circuit, and those waves run to the end of the circuit if they be not absorbed in the passage, and recoil in the same way that those waves in the rope do. So that if we consider what takes place in any circuit we have to imagine a vast succession of waves which travel one ofter another, but whose rapidity is so great that they entirely sub-

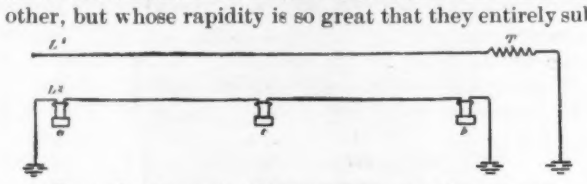


Fig. 13.—Carty's Experiments on Induction Interference.

side within a few hundredths, at the most, and very often within a few millionths of a second. In the case of Mr. Carty's experiments they probably would not last more than a few millionths of a second. There can be no doubt that those waves are there, and even supposing that the mathematical basis on which they rest were entirely destroyed by some fresh discovery, the researches of Hertz have placed those waves on a firm basis. Those oscillations of flow would not probably be a leading factor in this particular instance, but their existence must not be forgotten.

Mr. Carty: I go so far as to set forth that the effect of electromagnetic induction between parallel telephone wires may be neglected. That is, that when a man is talking on one wire and his speech is heard by induction on a parallel wire, that that speech finds its way between the two wires by virtue of electrostatic induction, and that electromagnetic induction is entirely negligible. I would like to describe a few experiments to prove that; and if they do not prove it I shall be very glad to have that fact pointed out.

I will now show what I consider the most favorable condition for creating electromagnetic induction between two telephone wires. In Fig 12 T represents the coil of a long distance transmitter sending the most powerful telephone current that it is now possible to generate. L^1 represents the wire connected to earth. It may be, we will say, 200 feet long. Parallel to it and an eighth of an inch away we will place another telephone circuit. These wires may have an insulation of 10,000 megohms and the resistance might be considered as one ohm. Now a current resulting from a given note in the transmitter through the wire (L^1) produces a series of changes in the magnetic field surrounding it, and that action is roughly explained by assuming that the current starting in L^1 induces a current in L^2 in the opposite direction, and that the induced current will flow through both telephones *a* and *b*. Now, it is a fact that under these conditions absolutely no sound is heard in the telephones *a* or *b*.

That represents the strongest current that it is possible to produce by that transmitter—the strongest changes—and consequently we should have the greatest fluctuation in the magnetic field surrounding the wire (L^1), but under

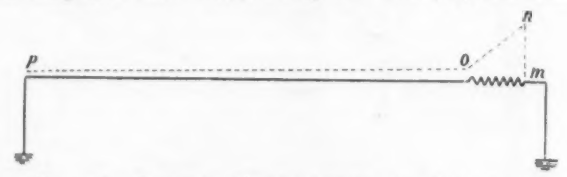


Fig. 14.—Carty's Experiments on Induction Interference.

those circumstances there is absolutely no disturbance whatever effected in the telephones *a* or *b* located in L^2. That, I think, is a crucial test.

Now I will describe an experiment which I made with those same wires. We will open the wire L^1 (Fig. 13) at the far end. Then, when the transmitter is operated, noise is immediately heard at the telephones *a* and *b*, located at the ends of the secondary wire, and if a telephone, *c*, be located at the exact centre of impedance it will be found to be silent. When the wire L^1 is opened at the far end we have the maximum electrostatic and the minimum electromagnetic action; when it is closed we have the maximum electromagnetic action and the minimum electrostatic action. The reason that the electrostatic action is slight in Fig. 12 can be seen from Fig. 14. Assuming that the *m n* represents the height of potential of the transmitter, the resistance of the circuit is mostly in the transmitter and the fall of potential therein is very sudden. At any point along the wire L^1 the potential would be practically zero, as shown by the dotted line *o p*.

If there is any fallacy in these experiments I should be very glad to have it pointed out, and if it is admitted that electromagnetic induction is negligible between actual telephone circuits, why I should be glad to have that come out also.

The President: Do I understand that you consider the earth as a zero resistance in comparison with the two hundred feet of wire?

Mr. Carty: I have assumed that we have a zero resistance in the earth, and as a matter of fact the experiment, as I have repeatedly tried it, was made using the same earth connection. In an experiment in this room you would probably connect through the water pipe, or there could be a return wire put in there—in that condition the resistance is zero. As a matter of common practice, if those wires were separated and you talked on them there would be no interference between them due to earth leakage.

I wish to show another experiment in proof of the fact, or what I think is a fact, that electromagnetic induction is negligible when we consider the action that goes on between two telephone circuits. I expressly limit the statement to the action between telephone circuits, and I am not discussing disturbances in general, but merely inductive crosstalk. Now, I will draw a line — L^2 — (Fig. 15), similar to the one I used before, and we will assume that the circuit is completed by a return wire of no resistance, or of very low resistance, entirely outside of the field of disturbance, so as to eliminate all questions of leakage through the earth. We will say that L^1 is grounded on a gas pipe. We then have the disturbing wire as before, and when the transmitter is operated loud tones are heard at the end telephones, *a* and *b*, thus: If this were entirely due to the creation of an electromagnetic field around the disturbing wire, the effect on the secondary wire would be increased by short circuiting one of the telephones by the key *k*. Now, it is found that when this is done, instead of increasing the sound in the other telephone it absolutely removes it. Now the case just described is another condition where you should get an increase of electromagnetic action, if the disturbance is due to the magnetic field, but the noise, instead of increasing, disappears entirely. Now, you will see how beautifully the thing may be explained by assuming that the disturbance is due to direct electrostatic action. In this case we will say that the wire L^1, at a given instant, has a plus charge upon it which induces a minus charge on L^2. Now, when the inducing charge is removed the induced charge divides and flows away at

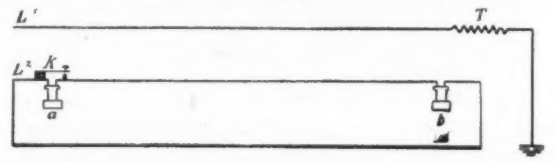


Fig. 15.—Carty's Experiments on Induction Interference.

both ends. But as there is a great deal of resistance in telephone *b*, and practically no resistance in key *k*, the charge and discharge of L^2 takes place up and down through the key end and none of it goes through the telephone *b*. Now, I think that is a complete refutation of the statement that any portion of the noise produced in the telephone is due to electromagnetic action. There is no doubt about it that when the current is going through L^1, in the act of charging it, that there is a magnetic field surrounding that current, but I have shown that it is so feeble that it does not produce any effect in the telephone; that is, the action that is due to the electromagnetic field is so feeble that the ear is not able to tell whether it is present or not.

Mr. George B. Prescott, Jr.: With reference to the first diagram I would like to ask Mr. Carty if he tried the simple experiment of interrupting a battery current in the inducing circuit by means of an ordinary telegraph key?

Mr. Carty: I am very glad that Mr. Prescott brought that up. I have an experiment that furnishes a very good illustration of how electromagnetic action works. I did not try it with an ordinary telegraph key, but I sent through a powerful current so as to get an electromagnetic field with which I could deal. Now in this case T (Fig. 12) represents (indicating) a vibrator connected with a large battery. We had a very powerful current flowing through that wire, L^1. The current was constantly vibrating, and it was a very strong current indeed. Now in that case I used the same secondary wire, and a telephone in the centre, and then we found a noise in all three telephones, just exactly what you should expect in dealing with electromagnetic induction. You would expect to find a current at a given instant, with very slight differences, constant in all parts of the circuit; that is, you would expect to find as much noise at the centre telephone as at the end telephone. You would expect that if this middle telephone were short circuited the noise would be increased at the end telephones, and then you would further expect that if one end telephone were short circuited that the remaining one would be still louder. That was the case. Now consider the circuit with the middle telephone cut out and one end telephone cut out and the other end telephone giving a loud noise, with a strong current in L^1; but with the strongest telephone current we could produce in L^1 there was no noise there at all. And, further than that, the methods of every-day practice have been changed to meet these views, and our predictions and calculations based on this way of working are invariably correct. All of our cables, which are twisted in pairs, are subjected to a very rigid crosstalk test, and some of the refinements which have to be taken into consideration in making those tests are certainly most surprising.

* For the full text of Mr. Carty's paper see The Electrical World of March 28, 1891.

These experiments were begun at Washington, I think, more than two years ago. They have been in the files of various companies and have been reported on by different people, many of them have been in the Patent Office and some of them are still in the Patent Office, and if there is a fallacy in the reasoning I am very anxious to find it out, because I have undertaken to point out an error in three authorities to-night, and I would like to withdraw my statements if they are wrong.

Mr. PRESCOTT: Mr. Carty admits that interrupted direct currents in the inducing circuit caused electromagnetic disturbances in the telephone wire. Does not, therefore, his first experiment only indicate that the effects of electromagnetic induction are slight in the case of feeble, rapidly alternating currents, that is telephonic currents?

Mr. CARTY: I mean that with the most powerful telephone transmitters in use, with the most powerful telephone currents which I have generated in practice, that the effect of electromagnetic induction is negligible, but that if it were possible to increase the strength of the current I am not prepared to say that electromagnetic induction would not then become a factor. All that I am saying is that for the present it is negligible.

Dr. LOUIS BELL: I think it is a pretty clear case that it takes a good deal stronger current than one would at first suppose to act inductively. I would like, as a matter of curiosity, to ask Mr. Carty if he knows what the numerical coefficient is of self-induction for one of those long distance transmitters, and about what is the largest current that is used in practice. I ask this, simply because it may facilitate computation of the possible effect if one should care to try it. In the case of interference between one telephone circuit and another, I think that unless the lines were most unreasonably close together that the ordinary magnitude of the current employed would not be sufficient to cause disturbance. I have worked it out roughly for heavier currents and the electromagnetic effect is not nearly so great as one would suppose.

Mr. CARTY: I have not the figures in mind, but that matter was investigated by Professor Cross, and he published a paper which can easily be found. I have no figures as to the transmitter coil. I think somewhere in Mr. Kennelly's paper he gives what the inductance of the long-distance transmitter coil is. I do not remember what it is myself.

The PRESIDENT: It seems to me that the experiments that Mr. Carty has described here are extremely interesting and very conclusive as to the effects that take place in a particular case. As I understand him, when his line is grounded at the farther end, in which case you will have a series of currents going back and forth upon it, currents as strong as the telephone transmitter is capable of producing, we have no induction whatever—no sound, in other words, in the telephone. And, therefore, electromagnetic induction is so small as to produce no effect that can be heard in the telephone; but when he breaks the ground and leaves the far end of that wire insulated, then operates the transmitter, the wire becomes length plus and minus, rising to a quite high potential, then falling to a low potential. We have at once the effect in both telephones indicating that the electrostatic disturbance is something considerable. It seems to me a very interesting fact and a very conclusive form of experiment.

Mr. CARTY: I would like to put it very clearly before the Institute that my experiments refer only to the disturbance which is produced upon one telephone circuit by induction from another, and that in my experiments I have used the human voice for a disturbing source and covered the entire range of telephonic currents. I have also used a musical note. That is, I have had a boy talking and reading. The original experiments at Washington were tried in the switchboard, and we had relays of linemen reading from the newspapers. At New York I used tuning forks, because they were more economical.

Mr. WILLIAM MINER: I would like to ask Mr. Carty if the same result is obtained when the wire that he uses at the top, L^1, is about three or four times the length of the secondary, and the secondary say a mile in length. The reason I ask this question is, that in the city of Chester, Pa., and about a mile from the Exchange—I had called the Exchange—when I heard the superintendent at Wilmington, Del., about three miles away, talking with the operator at the Chester Exchange; the wires running parallel, and both wires grounded. I spoke to the gentleman at Wilmington, and talked with him as well as I ever talked with any one through a telephone.

Mr. CARTY: I have never tried that experiment, but I have shown the most favorable conditions for developing an electromagnetic field around a telephone wire by the human voice, and the conditions which you name will certainly not be as favorable as the case I described. I predict that you would not get any electromagnetic induction between those telephone wires that originated in the transmitter. I would say further that all of my experiments have been reproduced, using condensers, which is an interesting point, and the results from condensers were exactly what I got from straight wires.

I wish to point out in addition that there must be some mistake in the reference given by Mr. Lockwood in his note. He says: "Mr. Culley presented a paper once upon this subject before the Society of Telegraph Engineers; which paper, together with a most instructive discussion, is published in the *Journal* of that society, and Mr. Preece and myself from time to time have also repeatedly referred to it." Mr. Culley has not read a paper of any kind before the Society of Telegraph Engineers or Electrical Engineers since 1875. That was before the invention of the telephone. Mr. Culley's paper of 1875 dealt with the induction of telegraph wires. I put in a foot note referring to Mr. Culley's paper in my Electric Club paper. I think that that must be what Mr. Lockwood means. I am very familiar with Mr. Lockwood's writings, but I have never seen anything about that in print. If any one else present has, I think it had better be put on record, as the literature of the subject is meagre at best.

Mr. H. FRANKLIN WATTS: I believe it is considered that electromagnetic induction, pure and simple, is produced by magnetic whirls surrounding the disturbing wire. I would like to ask if it is necessary to have an actual flow of current in the wire in order to produce these magnetic whirls? I am taking it for granted that the magnetic whirls, as I prefer to term them, are the true source of electromagnetic induction. That being the case, is a wire open at one end capable of producing these whirls? If such a wire is *not* capable of producing whirls, then, in the cases to which Mr. Carty refers, in which the wire is open, it is evident that it is due to something else besides electromagnetic induction. I am not able to say whether a wire which is merely charged and in which there is no flow of current will produce magnetic whirls or not.

Mr. CARTY: I think it must be admitted that in the act of charging the wire a current flows, and even although the end be open that current produces a magnetic field, and all of the effects, while it lasts, that would be produced by a current of the same character flowing in a closed metallic circuit. I think that the same thing would hold true of a current actually passing through the dielectric, until the dielectric is strained to its full limit—that even there it sets up a magnetic field. But in my paper I have endeavored to show — or rather in the discussion—that the current required to charge the wire is so small that the magnetic field produced by it is so slight as to be incapable of causing

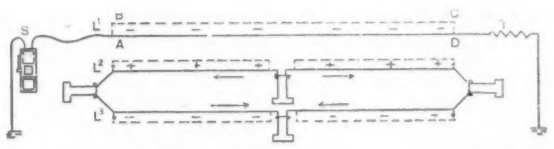


FIG. 2.—CARTY'S EXPERIMENTS ON INDUCTION INTERFERENCE.

the ordinary current induction or electromagnetic induction in the neighboring wire. If the far end of F^1 (Fig. 13) were open, but connected to a condenser of one microfarad, then the effect produced on the secondary wire would be practically just the same as though the wire were grounded by a conductor of small resistance. There is a case where the wire, when measured for its insulation resistance, might have an infinite resistance, and, according to the laws of steady currents, we could not have a current flowing in it; but, when you consider an alternating current, you know that the current flows in dielectrics until the dielectric is sufficiently strained.

Prof. FRANCIS B. CROCKER: Mr. President, it appears to me that the question resolves itself into a matter of degree. Mr. Carty states that the ordinary telephone currents, so far as his experiments have gone, fail to show any electromagnetic effect on each other. Now, he also tells us that under certain conditions where he had a very much more powerful current with a greater rate of change in current, he succeeded in getting the usual electromagnetic effect that we should expect, and that by cutting out resistance he increased the effect; whereas, in the case of the telephone current, the cutting out of resistance and inductance actually reduced the effect; showing that the facts were not what we generally expect in electromagnetic currents. Now, it seems to me that somewhere between these two conditions we must reach a balance point between the electromagnetic and the electrostatic action; in other words, the electrostatic action would equal the electromagnetic action. Mr. Kennelly has suggested how to calculate the value of the induction. It could also be easily determined experimentally, I think, keeping the line lengths and impedance constant, and varying the rate of change of current, and finding when the strength of the current or rather the rate of its change reaches a certain value, at which the electromagnetic effect is equal to the electrostatic effect. There must really be a limit. As soon as disturbances become audible then they are important. Before that, they are of no importance. Evidently there must be a point somewhere between the two cases given by Mr. Carty at which a sufficiently low impedance or a sufficiently great electromagnetic effect would give audible electromagnetic inductive disturbances. It is evidently a tangible question. Mr. Carty is right in saying that he considers only the ordinary condition of telephone circuits and telephone "crosstalk," and not currents which the ordinary telephone transmitters do not produce. Nevertheless, in order to be sure when the electromagnetic action becomes significant, which might be at a certain current—for example, five times as great as in ordinary telephone circuits—then we should know that ordinary telephone circuits are far below the electromagnetic-disturbance limit that is practically appreciable.

Mr. FRANCIS R. UPTON: It seems to me, by taking the precautions to do away with the crosstalk, that the magnetic induction that might come onto the circuit would be increased; that where the two go oppositely the precautions which would do away with static induction would increase magnetic induction; what would do away with the magnetic induction would increase the static induction. What I wish to know is whether these diagrams show anything that is in actual practice in telephone lines.

Mr. CARTY: Five hundred feet was the length of most of the lines used. But all of my practical experience confirms the experiments on these lines, and the system employed to do away with disturbances is effective for both electromagnetic and electrostatic induction. It is much easier to get rid of electromagnetic induction than electrostatic induction. In regard to a point being reached where the electromagnetic induction and the electrostatic induction are neutralized, I would say that I referred to it in the original report which I made on my first experiment—which, by the way, was for the settlement of a practical question involving the payment of a large amount of money—as to whether there was crosstalk or not in a given switchboard. One set of experts would go there and produce what they considered the most favorable conditions for obtaining crosstalk, assuming that it was electromagnetic. Now, as I have shown in that case, we would get none at all. So they would go back and report there was no crosstalk. The manager did not know what to do, because he was a witness of the experiment, and he would ascribe it to the weather or some other obscure cause. Another man would go and he might leave some impedance in at the far end of the disturbing wire, and in that case there would be crosstalk. While at Washington I found out what was the matter, and it occurred to me at that time that the two kinds of induction might conflict; that is, that a given impulse which would tend to produce a current in one direction would in that case meet one of the electrostatic currents and shove the neutral point one way or the other. The next impulse being in the opposite direction it would move the neutral point the other way. So, in looking for the balance, you want to bear in mind that the neutral point is shifting back and forth all the time.

Note on the Relative Degree of Disturbance Caused by Electrostatic and Electromagnetic Induction Between Telephone Circuits.

BY A. E. KENNELLY.

Referring to Fig. 2 of Mr. Carty's paper let L^1 be a primary line, L^2 and L^3 the lines of a secondary circuit. Suppose also, to simplify the conditions, that L^3 is so far remote from L^1 and L^2, by comparison with the half-inch of distance separating these latter, that all inductive influence on or from L^3 may be omitted from consideration. The most convenient way of dealing with L^3 is to replace it by the ground, and we have then only to consider the two circuits, L^1 and L^2, each as taken negligibly small for the case under discussion.

By considering, first, the amount of disturbance that would be statically set up in L^1, if electromagnetic action did not exist, and, second, the magnetic disturbance on the hypothesis that no static induction took place, it is possible to form a comparative estimate of the relative proportions of these disturbances, when, as in practice, both influences act together. The result will not be accurate, because the influence of each not only combines with, but also to a certain extent modifies, the action of the other; but the discrepancy due to so elementary a treatment will not in all probability invalidate the results of a first approximation

Let k be the mutual electrostatic capacity of L^1 and L^2 per centimetre length of each, in absolute electromagnetic units.

Let μ be the mutual electromagnetic capacity, or mutual inductance of L^1 and L^2 per centimetre of each in absolute electromagnetic units.

Let l be the length of each of the wires in centimetres.

Let e be the primary circuit electromotive force, which is periodic in value.

Let n be the number of periods completed by e per second.

Let ω_1 be the impedance in the circuit of L^1 in absolute electromagnetic units.

Let ω_2 be the impedance in the circuit of L^2 in absolute electromagnetic units.

Let γ_e be the current in each of the two end telephones of the secondary circuit owing to electrostatic induction when electromagnetic induction is supposed to be absent.

Let γ_m be the current in each of three telephones in the secondary circuit (one at the centre of L^2 and the others at its ends), when electromagnetic action is supposed to exist between the circuits to the exclusion of static induction.

Let q be the total electrostatic charge induced on L at any moment by static induction.

Let r be the radius of each wire (copper) in centimetres.

Let the wires be parallel and the distance between their

* A discussion of Mr. J. J. Carty's paper on "Inductive Disturbances in Telephonic Circuits" before the American Institute of Electrical Engineers, communicated to the secretary after adjournment.

axes be d centimetres in the horizontal plane elevated h centimetres above the ground.

Then if the end of L^1 distant from the transmitter be disconnected from the ground and electrostatic influence only be supposed to act upon the secondary circuit, the potential of L^1 at any moment will be e, the value of the periodic electromotive force while the induced charge upon L^2 will be expressed by

$$q = -e\,l\,k.$$

The flow of current from L^2 to ground will at any moment be the time rate of change in q, or numerically

$$\frac{dq}{dt} = l\,k\,\frac{de}{dt};$$

and since this by symmetry will divide equally between the two end telephones in L^2, the current in each is numerically

$$\gamma_e = \frac{lk}{2}\,\frac{de}{dt}.$$

Now with electromagnetic induction active, and static action suspended, the distant end of L^1 is connected to ground through a certain impedance. The current then existing in the primary circuit at any moment is

$$\frac{e}{\omega_1}$$

and in the secondary circuit $\frac{l\,\mu}{\omega_1}\frac{de}{dt}\cdot\frac{1}{\omega_2} = \gamma_m$ since this affects all three telephones alike.

Since γ_e and γ_m are periodic currents of the same frequency, they will produce equally loud sounds in the telephones when of equal numerical value, and the ratio of static to magnetic disturbance in the two cases will be

$$\frac{\gamma_e}{\gamma_m} = \frac{k}{\mu}\,\frac{\omega_1\,\omega}{2}$$

Provided then that the impedance of the primary circuit at the receiving end is always large, the ratio of static to magnetic disturbance will be approximately expressed by this equation. In order to apply it to the case of Fig. 2, we have to determine from the geometrical relations of the wires their mutual capacities k and μ.

The value of k in absolute electrostatic units has been given by Mr. Oliver Heaviside in the *Journal of the Society of Telegraph Engineers* (London) for April, 1881 (with a misprint in the formula here avoided)—

$$k = \frac{\frac{1}{2}\log\varepsilon\,\frac{\sqrt{d^2+4\,h^2}}{d}}{\left\{\log\varepsilon\,\frac{2\,h}{r}\right\}^2 - \left\{\log\varepsilon\,\frac{\sqrt{d^2+4\,h^2}}{d}\right\}^2}$$

Substituting for d 1.25 (centimetres or half an inch.)
for h 1,000 (centimetres or about 33 feet).
for r 0.1 (centimetres or 0.4″ about representing No. 12 B. & S. gauge).

$k = 0.0714$ absolute electrostatic units $= 7.94 \times 10^{-23}$ absolute electromagnetic units, or 0.0128 microfarads per mile.

The value for μ can also be found from another formula

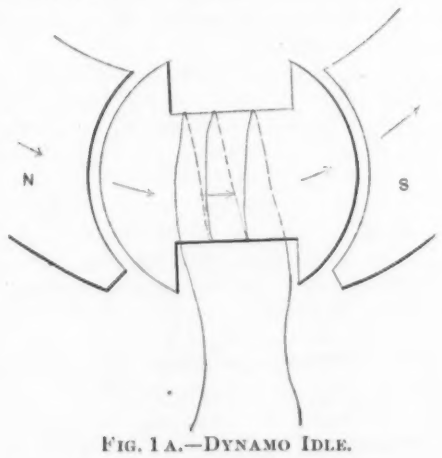


Fig. 1 a.—Dynamo Idle.

first published by Mr. Heaviside in the *Journal* of the above mentioned society for May, 1878, namely:

$$\mu = \log\varepsilon\,\frac{d^2+4\,h^2}{d^2}$$

from which $\mu = 14.75$ absolute electromagnetic units or 2.37 millihenrys per mile.

Thus for equality between γ_e and γ_m we must have with these values of k and μ

$\omega_1\,\omega_2 = 3.717 \times 10^{23}$ absolute electromagnetic units.

Three telephones of 75 ω and 90 h each would to a frequency of $n = 435$ corresponding to the note a^1 offer an impedance of $\omega^2 = 7.72 \times 10^{11}$ or 772 ohms, the impedance of the three telephones to this frequency being more than three times their resistance.

For $\gamma_e \div \gamma_m = 1$, ω_1 must now be $3.717 \times 10^{23} \div 7.72 \times 10^{11}$ or 4.816×10^{11} or 481.6 ohms, in round numbers 500, while with the primary circuit of Fig. 2 having a transmitter of 165 ω and 730 h with a call-bell at the distant end of 550 ω and 2.7 H, the total resistance would be 715 ω, the total inductance 3.43 H, and the impedance to the same frequency of $n = 435$ would be $9.40 \times 10^{12} = 9400\ \omega$ or about 13 times greater than the total resistance. The impedance ω_1 is thus nearly 20 times greater than that needed by the formula for equality between γ_e and γ_m and roughly the static disturbance in Fig. 2 may be estimated as 20 times greater than the magnetic.

Regulation of Constant Current Generators.*

BY ALEXANDER DOW.

Electric power expressed in watts is a product of two factors—the electromotive force and the volume of the current carrying the power. A change in the total power of the current may be expressed by a change of either factor, or of both. In distributions of electric energy it is usual to provide for adjusting the production to the requirements of the work by varying only one factor, the other being maintained constant from minimum to maximum production. Thus we have two commonly recognized methods of distribution—at constant electromotive force and with constant current. There are cases in practice where both factors may vary; for instance, when a series-wound dynamo operates one series-wound arc lamp, or when a shunt wound machine is employed to change one set of accumulators; but you will notice that in such cases there is but one device absorbing energy. Where

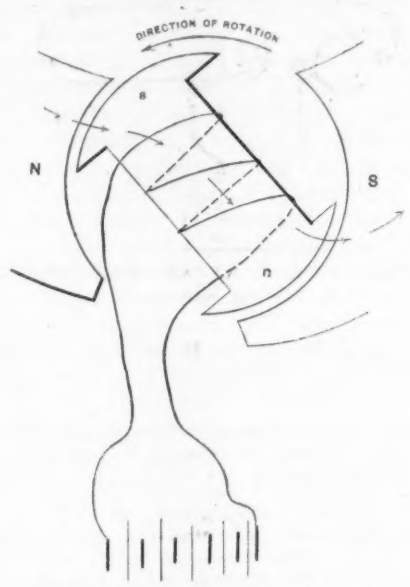


Fig. 1 b.—Dynamo as a Motor.

there is more than one absorber, the difficulty of keeping each of these in unison with the other compels the adoption of a one-factor regulation of the generator.

It is impracticable to supply from the same generator two devices, one of which requires a low electromotive force and a large current, and the other a greater electromotive force and a smaller current. But if they are alike in either requirements their operation together becomes practicable. We may say that it is this operation of more than one receptive device by the one generative circuit—this division of the energy—that has caused the differentiation of the two methods of distribution. And designers of electrical machinery have adapted their apparatus particularly to one or the other of these operating conditions, and have in their dynamos provided for the maintenance of the selected condition. This paper is a study of the regulation of constant current dynamos.

The book of the constant current dynamo is yet unwritten. The constant potential dynamo has its literature by libraries, and the literature of the transformer is accumulating daily; but the constant current dynamo is neglected by the book-maker. Those who wish to study it must go to the machine itself, and they will find it the least understood and the worst treated of all electrical generators. I have thought that a paper on this subject based on observation and practical study would be of interest to the club.

The theory of the dynamo electric machine as commonly taught is that the electromotive force developed by any dynamo depends on the rate at which the conductor under induction cuts lines of magnetic force. For the purposes of this paper we will accept this theory; and as regulation of the output of a constant current dynamo means changing its electromotive force, we see that any method of regulation is necessarily a method of changing the rate of cutting the lines of force.

In practice this cutting is by the conductors of an armature revolving in a magnetic field, and we see several possible ways of obtaining a change of rate. We can change the velocity of the conductor, run the armature at a lower speed and so do less cutting in a given time. Or we can reduce the number of lines of force intersecting the path of the conductor--reduce the "strength of field," as we say—and so give the armature wires less lines to cut. Or, third, we can change the length of conductor—the greater effective length of armature wire there is in the field the more cutting it will do per revolution. Any of these or any combination of them will serve to regulate the electromotive force.

The first way is the simplest and most efficient. Change of speed will alter the electromotive force of a dynamo, without complication and with absolute accuracy right down to the point at which it merely charges its own field magnets. I have an old table in my possession showing the proper speeds of certain dynamos for any number of arc lights from one up to the limit of each machine. It looks a little odd to-day to see the speed stated at "60 revolutions for one light, and 16 revolutions for each additional light." We are accustomed to setting speed for full load, and letting our automatic governors or engine and dynamos take care of any reduction of load. My own practice, when I have a plant with engine and dynamo capacity much in excess of present requirements, is to set speed at the minimum and increase it from time to time as increased business requires. Most automatic cut-off engines will govern at any speed within a wide range; and I gain electrical economy, a reduced friction card, and a saving in steam by reduction of cylinder condensation. The theoretical economy is obvious. The belt power is as torque X speed. The torque remains constant with the current, and the total power is reduced directly with the speed.

In water power plants regulation by speed is common. I saw recently a neat instance of this. The plant is two 20-light arc dynamos. There is an automatic governor to each dynamo, but these are depended on only to compensate for difference of load between the two machines. The attendant is guided by the ammeter of the machine carrying the heaviest load, and regulates entirely by the hand wheel controlling the water gate. It is interesting to note that the brushes need no attention when change of load is met by change of speed.

Regulation by changing strength of field has been brought to perfection in constant potential working, in the shape of compound winding. It is used also in constant current work, many of the most familiar devices depending primarily on change of field. But compound winding is not used to any extent. Such winding for constant current is "a hard road to travel." The first difficulty is to design a commercially and mechanically practicable shunt field for high voltages. Shunt wound arc dynamos have worked up to 1,200 volts, and worked well under favorable conditions. But 1,200 volts is too low for recent practice, and conditions are never favorable to an arc dynamo—well, "hardly ever." With the open coil dynamos, which have two or three independent commutators connected in series, it is possible to compound by a shunt connected to one commutator only; the shunt thus taking half or one-third of the total voltage. Power generators of this type are doing excellent work, but the extreme changes of lead under variation of load limit the applicability of these machines. Of course an automatic brush-rocker is suggestive as the one thing needed to make them generally useful, but to make a brush-rocker keep step with the instantaneous changes of field is another hard road to travel. I believe that up to date, when a sudden change of lead is in order, the compounding gets there ahead of the brushes every time.

To make a brush-rocker work properly on any style of power generator is a nice problem. The changes in arc lighting are perfectly manageable; it's the utterly unreasonable changes that come when you have a lot of big motors on a series circuit that show just how much momentum a rocker with little inertia and a perfected dash-pot can acquire. I counted the swings on such a rocker once when a big motor had been switched off suddenly. I counted up to 47, and it was not quite done then. But I believe that compound winding (with or without a rocker) will ultimately be the accepted method of regulation for constant current.

Before taking up the study of regulators of the field changing class, I must say something about armature reaction, *i. e*, the influence of the armature magnetism on the density of the field. A good deal has been written on this subject in connection with the Stanley constant current alternator. I have not seen that machine, so can say nothing about it, but any account of the familiar direct current regulators must take reaction into the reckoning. It is a feature of all and the most prominent feature of several, although it is invariably overlooked in published descriptions.

I want to make clear by a few diagrams the part which the armature of a dynamo constitutes in its magnetic circuit. I need not begin by a definition of the magnetic circuit, that idea, though it is only a conception of the last two or three years, has already reached the advertising department. But I state its fundamental law in order to lead up to the statements to follow: It is that the magnetic flux in any circuit—that is, the total number of lines of force, or what we call the strength of field, is directly proportional to the magnetomotive force; that means, in a dynamo, the number of ampère turns in its windings, and is inversely proportional to the magnetic resistance of the circuit. This last means that if the iron of the dynamo is poor, or the space between armature core and pole pieces is wide, or the field magnets long and thin, we won't get so strong a field for the same ampère turns as if the iron were good, and the clearances small, and the magnets stout and short.

Now the magnetic circuit of a dynamo is a compound one. It is not all iron or all air; it is iron and air and copper armature wire. The magnetic flux in this circuit under a given magnetomotive force, applied to the field magnets, can be calculated when the armature is not traversed by current from the known magnetic resistances of the iron and air and copper. But so soon as there is current in the armature the circuit becomes complex as well

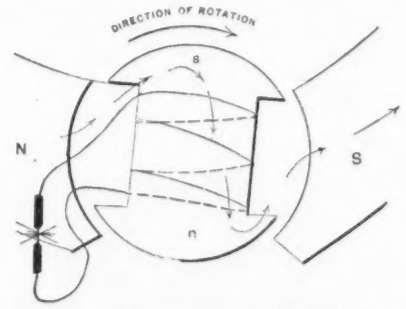


Fig. 1 c.—Dynamo as a Generator.

as compound. The armature becomes a magnet in its own right in virtue of the current circulating in its windings, and its magnetism may and does oppose that of the fields; so that the total magnetic flux or strength of field is changed and changes further as the current in the armature increases.

To illustrate this by my diagram (Fig. 1 *a*) let us conceive this armature to be free to move on its axis, but not traversed by current, and the field excited by a constant current from some external source. We have thus a magnetic flux from pole piece N to pole piece S, which takes as part of its path the iron core of the armature. Here we have an ordinary compound magnetic circuit.

Now we will conceive (Fig. 1 *b*) that the armature also is excited from some external source in such manner as to produce polarization n and s. We have now a marked tendency to get attracted poles in line in such manner as to get the best magnetic circuit—to get the straightest path for the lines of force. Or we may say in such manner as to form of the two independent magnets—the field and armature—one big magnet. This is what I call a complex magnetic circuit. There are two magnetomotive forces operating to produce a flux along the same path.

Our diagram as it stands only needs a commutator and brushes to be a motor. This pull between attracted and corresponding push between repelled) poles is the working power of a motor. The commutator acts by reversing the polarity of the armature at the proper instant, so as to make the attracted armature pole a repelled one and cause it to be pushed around into position to be attracted by the other field pole, and so on indefinitely.

Now we will conceive (Fig. 1 *c*), that we have a belt on our armature pulley and are driving it up to speed, and

* A paper read before the Chicago Electric Club, March 6, 1891

that the ends of the armature coil are closed on one another, say through an arc lamp. There will be currents induced in the armature coil, and these currents will polarize the core in such manner that each of its poles *N S* are attracted and held back by the field pole which it is leaving, and repelled by the field pole which it is approaching. That is, the work done in driving a dynamo, pulling attracted armature poles apart, and pushing them up to other poles which repel them.

I have selected the Siemens shuttle armature with one coil because its shape lets the eye note readily the relation of the field and armature poles, but you understand that the many coiled armatures have just such poles and attractions and repulsions. The only difference is that their polarity is more constant, as the one coil armature is without current twice in each revolution, while the many coiled armature is able to maintain its current always. And you understand also that the position of the brushes decides the position of the polarity due to the armature currents, as it is to one brush and from the other that the currents circulate.

Now let us examine the magnetic circuit as a whole. We have recognized the effort of the magnetic flux to secure the shortest path, and that the shorter the path the greater will be the flux. We will place the armature of our diagram in the position for maximum induction of current in its coil (Fig 1 c). The rotation is right-handed. Remembering that the pole of a dynamo armature which is leaving a field pole is always of the sign which that field pole would attract, we see that the upper armature pole is *S* and the lower *N*. Now let us lay out the course of the magnetic flux. We find that the lines which went

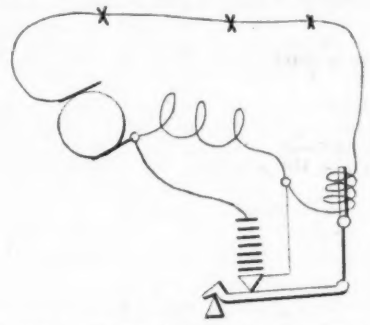


FIG. 2 A.—FIELD OF SERIES DYNAMO SHUNTED BY ADJUSTABLE CARBON RESISTANCE.

straight across from *N* to *S* of the field magnet when the armature was not generating current cannot do so now. They are repelled by the lower end of the armature, and obliged to bend upward toward the upper end. And they traverse the armature to its lower end, and again bend upward to reach the *S* field pole. You see that the resultant polarity of the area between the field magnets, which was formerly a straight line from pole to pole, is now a diagonal line, and that its departure from the straight line will be the greater the more the armature magnetism increases—that is armature reaction. I find it convenient to think of the reaction state as a lengthening of the magnetic circuit. You see the lines of force now take a crooked, long path instead of the short, straight path they had before the reaction commenced; and the effect on the field is just the same as if the magnets had been made longer or the air space made wider. You don't get so strong a field when reaction sets in, although your exciting current or magnetomotive force remains the same. Indeed, in dynamos designed to take advantage of this reaction, you don't get so strong a field for a greater exciting current.

I have not overlooked in preparing this paper the effects due to the induction of currents in the field windings by the armature. We must not forget that induction works both ways; that the inducing coils are subject to back in-

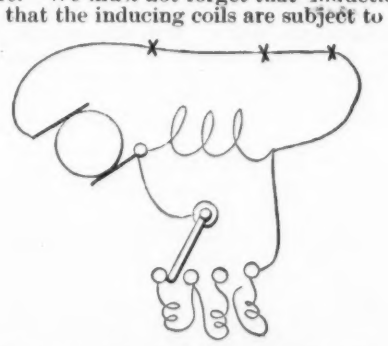


FIG. 2 B.—FIELD OF SERIES DYNAMO SHUNTED BY ADJUSTABLE WIRE RESISTANCE.

duction from the currents they induce. This effect is very marked in separately excited alternators and produces peculiar results. I omit this matter intentionally as not absolutely necessary to my main subject. Then I could explain armature reaction in another way by describing the free poles of the field and armature surfaces and their induction of poles of opposite size on adjacent surfaces. But I want to add here to the simple conception of the magnetic circuit. These other effects can all be expressed as qualities of the circuit, and do not oppose its conception as I have drawn it. And moreover, my diagram is not necessarily an imaginary one; for you can get just such a diagram by the use of iron filings from an actual dynamo.

Please remember, when we come to examine regulation by changing strength of field, that this armature reaction, or lengthening of the magnetic circuit, is least when the field magnetism is strong relatively to the armature, and greatest when the armature magnetism is stronger than the field. I want you to notice that if the field is weakened by some external cause the armature immediately has more reactive power and weakens it still further. And please note also that if the armature polar axis is carried forward by any cause, such as the displacement forward of the brushes, this change will lengthen the magnetic circuit. We are familiar in constant potential work with the rule that the lead necessary to be given the brushes depends on the displacement forward of the interfield polar axis. This rule is reversible, for the position of the axis depends on the lead given to the brushes.

The most familiar regulators of the field-changing class are those in which an adjustable resistance is connected in shunt to the field winding of a series dynamo. The adjustable resistance may be a rheostat of the conventional type, with a moving contact lever, or it may be a stack of carbon plates, the resistance of which will be reduced as they are pressed into more intimate contact with one another. Or it may be a trough containing liquid with electrodes which can be moved toward one another or immersed further into the liquid to get more surface contact. All of these are in every-day use. We notice that wherever they are in successful use the variation of the resistance is controlled by a small relay in the main circuit and that the heavy mechanical work of the device is performed by magnets in a local circuit, or by the power driving the dynamo. This use of a sensitive relay is necessary to accurate regulation. It eliminates many errors such as those due to heating of wire or carbon resistance, to polarization and change of density of a liquid resistance. The requirement for good practical regulation of an arc circuit is that the relay shall be more sensitive than the arc lamp. It is frequently so delicate that it responds promptly to a variation of current of one-fourth of one per cent.

There are dynamos widely used in which the function of the control relay is assigned to a magnet which has also

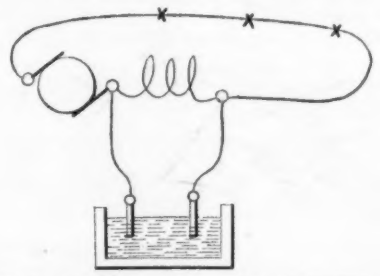


FIG. 2 C.—FIELD OF SERIES DYNAMO SHUNTED BY ADJUSTABLE FLUID RESISTANCE.

considerable mechanical work to perform, and is necessarily less sensitive as its duties are increased. Most of these dynamos obviously suffer in their regulation from this cause.

To come back to diagrams. Here is (Fig. 3) another way of varying field magnet strength. It is in use on the Hochhausen dynamo and motor, and is quite accurate when the field is divided into many sections. A similar arrangement where the field coils, instead of being altered in number are subject to permutations and combinations that vary the number in series, is in use on two systems of series-wound street car motors. This does not work so well as the Hochhausen plan because it is limited to a few gradations, and it is usually combined with a resistance called an "easy-starting coil" to make it less jerky in its operation.

Work first to change the ampère turns in the field coils. The shunt arrangements change the ampères, and the commutator arrangements change the turns. That means a reduction of magnetomotive force, but the magnetomotive force in the armature remains the same, its ampères and turns are constant, and so there is armature reaction. The polar axis of the interpolar arch shifts forward, and the brushes have to follow to stop sparking. This very carrying forward of the brushes shifts the interpolar axis still more because it shifts the armature axis, and so the reactions continue till equilibrium is reached. Now we have as a result a longer magnetic circuit than before regulation began—more magnetic resistance as well as less magnetomotive force, therefore a double reduction of the magnetic flux or field strength.

Some of you may have been accustomed to think of the reduction of electromotive force under field regulation as due only to change of exciting current. The changes of lead under such regulation should indicate the actual process to an observer, but not one published description takes account of anything but the fall of field current. If you wish to understand clearly the process, I suggest that you put an ammeter in the field circuit of your dynamo. You will possibly find a reduction of electromotive force of 90 per cent. to follow a reduction of only 45 per cent. in the exciting current.

We come now to consider that class of regulators which operates by moving the brushes of a closed-coil armature. There is a marked difference in this method as applied to

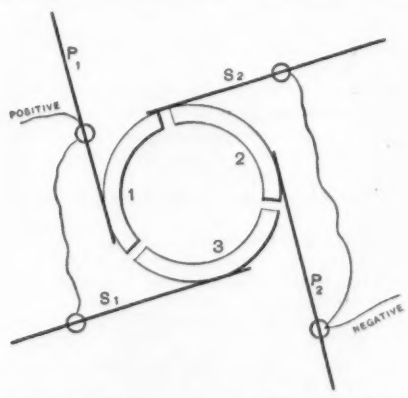


FIG. 5.—POSITION OF BRUSHES FOR MINIMUM LOAD. SHORT CIRCUIT ON SEGMENT 1.

open coil armatures, and we will consider now only those having gramme or Siemens windings. There are a number of dynamos in this class. Some regulate well, some miserably.

The most common explanation of this regulation is by the well-known "diagram of potentials," showing that near the neutral point the brushes are on the diameter of maximum difference of potential, and that 90 degrees distant they would find a diameter of equi-potential, and, of course, that any desired intermediate potential difference can be had on the proper intermediate diameter. And you can, by using a voltmeter, not the brushes, get just such a diagram off any of these machines, so, of course, the explanation is complete. But I have harbored for a long time the wicked suspicion that this explanation didn't explain, even though it was put forward with a great big diagram to illustrate it right in this club. And this was what aroused my suspicion. I looked at the diagram and saw that if I rocked forward those brushes 45 or 50 degrees I would get just half the maximum potential. Then I looked at a machine and found that if I rocked forward the brushes 45 or 50 degrees, I didn't get any potential at all. Then I looked at more machines, and more and more of them, and they all had this utterly unjustifiable departure from the diagram which they were bound to live up to. And so my suspicion grew.

Now, I don't operate an arc machine of this kind, and so, could not apply the practical methods of investigation, but there fell into my hands lately a 400-ampère incandescent machine, which had the same characteristic of a rapid fall in voltage as the brushes were rocked forward, and the same marvelously sparkless commutator that the best of these arc machines possess. I said the best of them; they are not sparkless as a class, and some of them can eat more copper than any open-coil dynamo.

So I went to work on my 400-ampère machine with a voltmeter, and I got a beautiful potential curve. Then I calculated the position which would give me 5 per cent. reduction in voltage, rocked the brushes forward, and got a 10 per cent. reduction. And so on it was in every position in which I could try it.

Then I got hold of a series-wound dynamo and run it on a resistance. I rocked the brushes backward and forward as far as the spark would permit, and found that I could vary the current from maximum about 40 per cent. downward. Then I tried what effect varying the field current would have in comparison with changing the lead, and I found that variation of field current simply wasn't in it; a little change of lead would neutralize all the variation I could control.

Here were two machines that had but one thing in common with the arc dynamos, namely, a strong armature compared with their fields. And they show the same quality of regulation by brush rocking as did these special arc dynamos. My suspicion was becoming a theory at a rapid rate.

Then I bethought me once more of all the arc dynamos I had ever known that regulated in this way. I singled

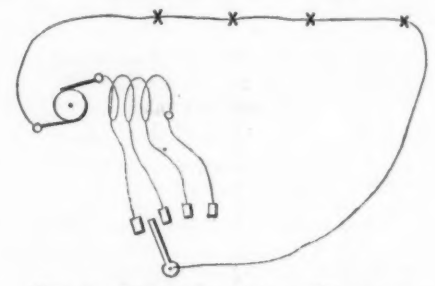


FIG. 3.—COMMUTED FIELD WINDING.

out two that I knew could be adjusted to a fraction of an ampère, over a long range of E. M. F. These two had Gramme armatures—the type that gives the strongest magnetic reaction. They had also fields of small value compared with the armatures. And I bethought me of two others which I knew would not regulate within 10 per cent. at low E. M. F. These two had armatures of a different type which gives the least magnetic reaction, and had massive fields; in fact, bad fields of a pattern which has proved admirable in controlling variation of lead in incandescence work. I remembered also that these two carried a bad spark at small loads. Also that one of them had practically been driven out of use by that spark, and that the other, which had a splendidly designed commutator and so could stand the spark, had been improved by changes tending to weaken its field. And so I formulated the theory that regulation by brush rocking depended on armature reaction, and that, consequently, the essential condition to success under this method was a magnetic circuit in which the armature magnetism had large value in comparison with the fields. I will try to verify that theory

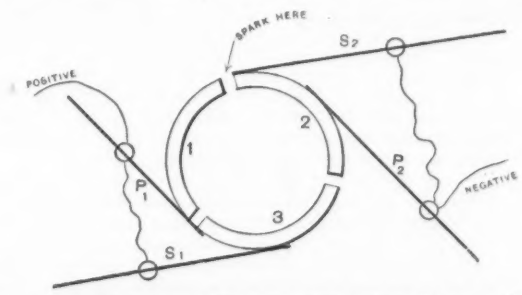


FIG. 4.—POSITION OF BRUSHES FOR FULL LOAD. SHORT CIRCUIT ON SEGMENT 1; P P, PRIMARY BRUSHES; S S, SECONDARY BRUSHES.

when I get a good opportunity. In the meantime it is up for discussion.

Now there is one more method of constant current regulation in use that cannot be left out of any paper on this subject. It is regulation by changing the effective length of armature conductor, and its sole representative is a well known open coil dynamo—the Thomson-Houston. You are doubtless familiar with the brush arrangements of this peculiar machine, and know that its regulation of E. M. F. is by a device which short circuits the armature. But to assist your remembrance I have here two diagrams, showing the full load (Fig. 4) and minimum load (5) positions of the brushes and their contact with the segments at these positions. Notice that in the minimum position the armature is absolutely short circuited from brush to brush during half of the revolution. That is, it is short circuited six times in each revolution and each time during 40 degrees of its movement, a total of 180 degrees. This period of short circuit is gradually reduced in its duration, although it still occurs six times per revolution, until the full load position is reached, when it is almost nothing. It would be absolutely nothing if it were not for the spark. The metallic contact is broken, but the spark under the tip of the secondary brush has conductivity, like any other electric spark, and so gives a momentary short circuit.

I have defined this regulation as by changing the effective length of armature conductor, and you see the reason of the definition. Of course the actual length of armature conductor is unchanged, but the effective length is, in virtue of the fact that the armature conductor is closed on itself, and forms a local circuit by itself, having no connection with the circuit under regulation.

A similar method is applicable to any open coil machine which "cuts off" the coils passing the neutral point. If an active coil be thrown into parallel with an idle coil, the two form a local circuit and are so removed from the circuit under regulation. This method is somewhat unmanageable as a device for adjusting output to load, but can be

and is employed to get special results in the design of open coil commutators.

Let us consider the internal process of regulation in the dynamo which short circuits its armature. The actions following the short circuit of active armature coils are complex. We expect the most noticeable to be the development of a tremendous current in the short circuited coils, with great heating, and our experience with short circuiting of individual sections of armatures would lead us to predict the early destruction of the winding from this coil. And that is just what many electricians do predict. The facts do not bear out the predictions. This armature, though not noted for exceptional long life, makes a very good showing in that respect, and its burning out when it does occur is not attributable to the excessive heating of its windings under regulation.

The enormous short circuit current begins to develop but meets reactions which arrest its growth. To consider these: a short circuit occurs six times in a revolution. That means in a dynamo running at 800 revolutions that this abnormal current is started and arrested 4,800 times per minute. In other words, that it is a periodical current with a periodicity of 80. This periodical current is developed in two coils of great length, of many convolutions, wound on an iron core; in other words, in a circuit of great inductance, and so being subject to the laws that govern periodical currents in inductive circuits—just the same laws that govern alternating currents in converters—it attains a very small mean value and has proportionally small heating effect. And, if we stop the consideration of the subject here, we could understand that the coils so short circuited would be little more likely to heat than if carrying only the regular current.

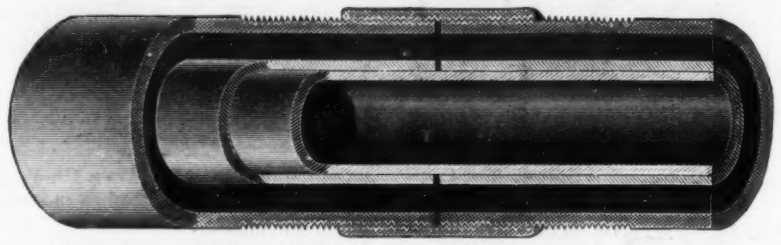
But there are further reactions to be considered to understand the operation of the regulating device. There is a direct reduction of the field of force, due to the cutting off of the exciting current by the short circuit at the brushes. The armature is closed on itself and sends no current to the field coils, and this cessation of magnetomotive force implies a cessation of magnetic flux—"a loss of field." The field goes gradually, returning its accumulated energy to the circuit which supplied it in the shape of an "extra current" in the same direction as the exciting current, and this "extra current" passing to line occupies the time between armature currents and makes the line current continuous. It is undulatory, not intermittent, as it would be but for the discharge of the field magnets. The process is reversed when the short circuit is removed from the armature. The armature current has risen above normal and carried up the armature magnetism with it. This accumulated energy would pass to line as a sudden "extra current," but is retarded by the partially discharged field magnets, and expends itself in carrying their magnetism up toward its normal value. This is a good example of the "steadying effect" of a magnet on a pulsatory or intermittent current. And there is still another cause reducing the induction. We have seen that there is a slight increase in the armature magnetism, and also a decrease in the field magnetism. That means that the equilibrium of polarity established between the armature and field in their normal relation is now disturbed. We have outward evidence of this in the necessity for moving forward the secondary brush of each pair in order to minimize sparking—the "lead" has obviously changed.

We observe that the designers of the dynamo found it well to introduce some complication on this account. They move both brushes of each pair and these in opposite directons and for different angular distances. The short circuiting for regulation could have been accomplished just as well by the rocking backward of the primary brush, but change of lead results therefrom and so to keep on the point of least spark the secondary brush has to go forward. And we have seen earlier in this paper that any forward change of lead signifies a lengthening of the magnetic circuit and a consequent reduction of the field value. Thus the regulation is effected not only by removal from circuit of the conductors cutting lines of force but also by actual reduction of the number of lines of force in the field. And further we see that this reduction of field is due both to a decrease in magnetomotive force, in that the exciting current becomes intermittent; and to increased resistance of magnetic circuit in that the resultant polarity of the armature is displaced forward, virtually lengthening the path to be taken by the magnetic flux. The same reduction of field that affects the working circuit influences also the local circuit of the armature and aids in preventing any injurious increase of current or heating of the short circuited coils.

It will be asked why the operators of these dynamos avoid running them on a few lamps, and what cause there is for the frequent statement that they heat when worked on a minimum load. The explanation is simple, if we again consider the action a periodical or intermittent current. We observe that as the load decreases the short circuiting becomes more lengthened and the currents delivered to the field coils become more markedly intermittent. These coils are wound on an iron core, and it is to the iron we must look for the heating. It is in exactly the same relation to the field coils as are the secondary winding and iron core of an induction coil to its primary, and it is not laminated as is the core of the induction coil, nor is it, like the secondary, provided with an external circuit for the utilization in external work of the currents developed in it. It is to these induced or Foucault currents that we must attribute the heating of the dynamo at short loads. My experience with this machine is that the heating seldom becomes objectionable in practice. If it were necessary to eliminate it, lamination of fields and additional lamination of armature would be the obvious remedy. I am not sure though that the cure would not be worse than the disease.

The last point I can take up in this paper is the influence which the work a dynamo is doing has upon its regulation. Of course the work of a dynamo can be expressed as so many watts, no matter how the current is employed, but practical men recognize that certain classes of work, though they may not exceed in watts certain other classes, are much more severe on the machine and trying to the regulation. I have spoken of the difficulty of regulating with series motors on a constant current dynamo. That is the meanest work you can put a machine to, and the fact that so many lighting stations have developed a paying and satisfactory business in supplying current to such motors is a big compliment to American electric light men. Just think of the changes a dynamo has to meet when it is in circuit with a motor which occasionally holds up a runaway by backing its brushes and acting as a generator.

The motor circuit is notoriously the hard one; but many practical men have noted that there is difference in facility of regulation with different arc lamps in circuit. Thus the differentially wound arc lamp, with a strong magnet in the main circuit, is an easy lamp to regulate for. The discharge from the series magnet helps the dynamo during a momentary overload, and so does the shortening of the arc. But the shunt wound arc lamp—the so-called "open circuit"—lamp is just the reverse. The discharge from its magnet goes through its own arc, and for all small changes of current its action is to lengthen the arc for a decrease and shorten it for an increase, and so put more work on the dynamo regulator. The series incandescence lamps behave in a similar way. A circuit with a large proportion of these is always hard to pull. For instance, the machine flashes and loses its field. If only arc lamps were in circuit they would drop to the idle position, and the dynamo would practically be short circuited and build up its field again at once. But the incandescent lamps get time to cool and their resistance increases so much that the dynamo has a circuit badly adapted for quick building up. I have seen it necessary to cut out the loop containing the series lamps in order to get a field quickly, although the dynamo picked them up at once when they were switched in after the arcs had lighted.



INTERIOR CONSTRUCTION OF SINGLE DUCT CONDUIT.

In concluding I would suggest to you the adoption in your studies of the expression I have used for the armature reaction effect; namely: *Lengthening of the magnetic circuit.* I submit that the expression has the following advantages—it explains the observed effect; it conforms to the now generally received law of the magnetic circuit, it can be expressed in terms of magnetic resistance, just as can the effect of any other change of magnetic circuit; it admits readily of graphic illustration, and can be shown by an iron filing card taken from an actual dynamo.

The terms *armature reaction* and *cross magnetization* don't fit with the idea of the magnetic circuit. The expression of the effect as so many negative ampère turns has been employed, but it is confusing to consider a condition as a reduction of magneto-motive force when that theoretical condition is accompanied by an actual increase of ampère turns. I propose to count all ampère turns of field and armature as positive, and to express the reduced magnetic flux following distortion of field as due to increased length and therefore resistance of the magnetic circuit.

Magnetic Vane Ammeters and Voltmeters.

The construction of the "magnetic vane" ammeters and voltmeters, as brought out by Queen & Co., has been somewhat changed since they were first placed on the market, their distinctive features being: Absence of permanent magnets, accuracy, strong construction, and handsome appearance.

Queen & Co. do not claim that these instruments are absolutely accurate, but that they are quite accurate enough (within one or two per cent.) for commercial purposes. As they contain no permanent magnets the annoyances due to this cause are entirely absent. The instruments contain no delicate parts, but are of solid construction, well adapted to usage which station instruments necessarily receive. The voltmeters, as well as the ammeters, can be left in circuit, so they may be fastened permanently on the switchboard if desired.

MAGNETIC VANE VOLTMETER.

The magnetic vane instruments are designed especially for central stations, isolated plants, marine installations and railway work, and are well adapted for general experimental work. The large ammeters are made to measure currents of any desired quantity, though 500 ampères is the largest size in the company's catalogues.

In marine work, where space is limited, the ammeters and voltmeters must not be affected by proximity to the dynamos or by the motion of the vessel. The magnetic vane instruments have been largely used for such work by some of the large construction companies, with very satisfactory results.

The voltmeter shown in the accompanying illustration is intended for electric railway work. It is calibrated up to 600 volts, and has a special short circuiting key for rapid work.

A Single Duct Conduit.

In order to meet a demand which has arisen for a single duct conduit of cheap, durable efficient character, the Interior Conduit and Insulation Company has adapted its well known insulated tubing to fit telescopically into a wrought iron pipe. Its construction is well shown in the accompanying illustration. The full space between the tubing and the iron is filled in with insulating compound, shutting out all moisture and gases. These pipes are made up into 10-foot sections, and when laid are coupled together by suitable wrought iron couplings.

In laying, these sections are converted into a continuous duct having practically no junctions by employing individual insulated tubes whose lengths are the same as the iron pipe sections, but whose external diameter is slightly less than the internal diameter of tube contained in the iron pipe.

These individual tubes are coated at the moment of laying with an insulating compound or cement and telescoped into the iron pipe section to the depth of just one-half their length in each section. A liberal supply of cementing compound is then placed upon each end of the sections to be joined and the ends of the iron pipe brought together firmly by a screw coupling. The insulated iron covered duct thus formed of two complete insulating tubes cemented together becomes to all intents and purposes as perfect in its continuity as if manufactured in the factory in one unbroken length.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

Electrical stocks have not been particularly active during the week. Prices have been steady, and no fluctuations of any moment have been noticed. Railroad shares have at last shown some symptoms of activity, and the market for them closed quite strong. This is the first evidence of life in railroad shares shown for some time past. The bond market is still strong.

Money on call is 3 per cent., and 5 per cent. was offered for money at three months. Commercial paper is 7 per cent. A statement is made that many Western bankers are unwilling to loan money for any lengthy period for less than 8 or 10 per cent. In London money on call closed at 2 per cent.

Interior Conduit and Insulation Company.—Among the events of the week in electrical stocks has been the offer of $300,000 of Interior Conduit and Insulation Company stock for sale. This represents an increase of capitalization, and the statement is made that one of the strongest banking-houses of New York City has underwritten the stock for $75 a share. This increase of capitalization was made to procure funds for the purchase of the business of Bergmann & Co., well-known manufacturers of gas and electric fixtures. The Interior Conduit and Insulation Company has been successful in its new field. A large amount of its interior conduits have been used with good results, and the financial statement made in the circular calling for subscriptions to the stock shows the company to be in excellent condition.

Bell Telephone.—Thos. B. Bailey has been elected a director of the American Bell Telephone Company in place of Stanton Blake, deceased. Report at the annual meeting showed gross income to be $4,375,290, the same being an increase over last year of $330,586. The net income is reported as $2,869,418, the same being an increase of $207,530. Surplus for the year was $122,975, the total surplus on hand being $2,151,011. The number of instruments under rental, 483,790, the same being an increase of 38,929 over last year. The stock of this company on the strength of the favorable statement has been quite active and closed at 197 bid, 197½ asked. A full synopsis of the report is given on page 273.

Erie Telephone Company.—The directors of this company have accepted the proposition of the Texas syndicate to purchase a portion or all of the stock of the Southwestern Telegraph and Telephone Company owned by the Erie company, subject to modifications which have been accepted by the syndicate mentioned. It is estimated that the $700,000, which is named in the transaction, would give the Erie stockholders $14 per share extra dividend. The purchase money will probably be paid in installments, and not in a lump sum.

New England Telephone and Telegraph Company has declared a dividend of 75 cents a share on its capital stock, payable April 15.

Thomson-Houston International Electric Company has declared a 3½ per cent. dividend on preferred stock, payable April 15. F. M. Z.

The Closing Quotations of electric stocks, from F. Z. Maguire & Co., electrical securities, 18 Wall street, New York, on Saturday, April 4, 1891, in New York, Boston and Washington were:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
NEW YORK.				
Western Union Telegraph Co.	100	86,200,000	80¾	80⅞
American Telegraph & Cable	100	14,000,000	83	85
Central and South American	100	5,600,000	*145	160
Mexican	100	2,000,000	*210	220
Commercial Cable Co	100	7,716,000	104½	109
Postal Telegraph Cable	100	5,000,000	39	41
Edison General Electric Co.	100	9,503,500	100	102
Consolidated Electric Light	100	1,925,400	....	....
Edison Electric Illuminating Co.	100	2,567,800	79	80
United States Electric Light	100	1,500,000	....	....
North American Phonograph	100	6,200,000	....	....
BOSTON.				
Thomson-Houston Electric Co.	25	6,000,000	44¼	45
" " preferred	25	4,000,000	25	25¼
" " Series C	10	400,000	9¼	10
" " Series D.	10	120,000	7	7¼
" International Co.	100	1,000,000	....	....
Thomson Welding Co.	100	1,000,000	....	....
" European Welding Co.	100	1,000,000	....	68
Ft. Wayne Electric Co.	25	4,000,000	12¾	13
Westinghouse Electric Mfg. Co.	50	5,000,000	11¾	11⅞
Telephone:				
American Bell	100	12,500,000	197	197½
Erie	100	4,800,000	49¾	50¼
New England	100	10,504,600	50	51
Mexican	10	1,280,000	90c.	95c.
Tropical American	10	400,000	80c.	87½c.
MISCELLANEOUS.				
Edison Phonograph Doll	10	1,000,000	....	1
WASHINGTON.				
Pennsylvania Telephone	50	750,000	25	34
Chesapeake & Potomac	100	2,650,000	58½	60
American Graphophone	10	600,000	6	6⅛
United States Electric Light (Washington)	100	300,000	167	170
Eckington and Soldiers' Home Electric Ry.	50	352,000	56⅜	60
Georgetown and Tennallytown	50	200,000	60	65

*Ex dividend.

Chicago Quotations.—Col, S. G, Lynch, broker, 153 Mon

roe street, Chicago, furnishes quotations on telephone and electric light stocks as follows:

Chicago	$225@$245	Cumberland	$60@ $62
Central Union	56@ 57	Wisconsin	118@ 120
Michigan	85@ 86	Bell of Missouri	160@ 165
Great Southern	30@ 3	Iowa Union	20@ 22
Colorado	34@ 36	Missouri and Kansas	54@ 56
Rocky Mountain Bell	40@ 43		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$100@$102	Chicago Edison	$140@$150

AFFAIRS OF THE COMPANIES.

The Capital Electric Light, Motor and Gas Company, of Boisé City, Idaho, will increase its capital stock from $20,000 to $50,000.

The Fisher Electric Company, of Detroit, Mich., reports its capital as $50,000; paid in, $14,536.22; real estate, none: personal estate, $27,178.77; debts, $17,204.20; credits, $9,213.97.

The Waynesboro (Pa.) Electric Light Company has elected the following officers for 1891: President, Daniel Hoover; secretary, D. H. Geiser; superintendent, J. F. Geiser.

The Cobb Vulcanite Wire Company, of Wilmington, Del., held its annual meeting on March 25, 1891. The officers elected for the ensuing year are: President, Edw. T Davis, of Philadelphia, Pa.; vice-president, Chas. N. Trump, of Wilmington, Del.; and treasurer, John F. Miller.

The Bristol (Pa.) Electric Light Company, at its annual meeting, declared a five per cent. dividend. The officers elected for the ensuing year are as follows: President, George A. Shoemaker; secretary, A. Weir Gilkeson; treasurer, Charles E. Scott; directors, Frank Bell, George A Shoemaker, Leopold Landreth, W. H. H. White and A. Weir Gilkeson.

The Federal Telephone Company, of Montreal, Can., held its annual meeting last week. The various reports were considered very satisfactory, there being a surplus over from the year's business. The old board of directors was re elected, with Mr. W. Cassils as president, Mr. J. Forget as vice-president, and Mr. James Wright as manager.

NEW INCORPORATIONS.

A New Railway Equipment Company.—Messrs. R. A. Robertson, E. C. Caleyron, M. A. Yeatebey and P. J. Hotaling, of Cleveland, O., have formed a company with a capital of $50,000 for the manufacture of a new trolley protector and tram car friction brakes.

The Chicago North and South Elevated Railway Company has been incorporated to construct and operate an elevated railway; capital stock, $10,000,000; incorporators, J. Almon Austin, George G. Newbury, W. Rosser Cobb, Samuel T. White, William C. Goudy, John A. Doherty and Charles S. Thornton.

The Barnwell (S. C.) Electric Light and Power Company has been incorporated, with a capital stock of $5,000. Incorporators: S. Duncan Bellinger, P. M. Buckingham, A. T. Woodward, Theo. J. Simmons, Wm. McNab and G. K. Bryan, all of Barnwell. The capital is $5,000, divided into 50 shares of $100 each.

The Chester (S. C.) Development Company has been incorporated with a capital stock of $200,000, to deal in lands, operate water, gas and electric light works. Incorporators: S. H. Stewart, James S. Simmons and L. W. Jamison, of Roanoke, Va., and James K. Henry, Paul Hemphill and E. C. Stahn, of Chester.

The Bala and Merion Electric Company has been incorporated at Bala and Merion, Pa., with a capital stock of $28 0 0, for the supplying of electric light and power in the town of Merion. The business offices are to be at Bala. The directors are: Charles E Hartshorne, of Merion; George R. Roberts, of Bala; Cyrus Chambers, Jr., of Overbook, Pa.; Lincoln Godfrey, of Merion; James A. Logan, of Bala; J. L. Stadelman and Charles E. Pugh, of Overbrook, Pa.

The Electric Manufacturing and Gas Engine Company, with a capital of $75,000, has been incorporated. The factory is situated on Greenbush Heights, N. Y., where the old Red mill was. The building has been used for the past few years as a manufactory for electrical instruments. The trustees are: Edward N. McKinney, Albany; George H. Ennis, Troy; Robert J. Pratt and James Hyde Pratt, East Greenbush, and Arthur Rollanson, England. William Bayard Van Rensselaer, of Albany, is one of the incorporators.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, April 6, 1891.

Mr. T. W. Ness, of Montreal, Que., one of the largest supply dealers in the Dominion, was in New York this week, the guest of Mr. A. F. Stanley.

Mr. Norman McCarthy, for several years past in the Thomson-Houston Company's railway department, has resigned. Mr. McCarthy has not as yet decided what he will do.

Mr. Fritz Achalis, president of the India Rubber Comb Company, the well-known manufacturer of electrical specialties, sailed for Europe this week to be gone during the summer. "Vergüngte Reise!"

Mr. H. C. Spaulding, of the Thomson-Van Depoele Mining Company, of Boston and Lynn, Mass., was a visitor to New York this week. The growth of this concern has been so rapid that now all of factory "J" at Lynn is occupied by the mining company.

The American Standard Electric Light Company has opened offices and showrooms at 106 and 108 Liberty street. This company controls the Holcomb, Crandall and Copeland patents on dynamos and arc lamps. J. G. Hyatt is president; Henry Alton, treasurer; George Taylor, secretary, and L. M. Shate is vice president and general manager.

The Investors' Security and Account Company, of New York, is building 19 miles of railway called the Denver & Suburban Railroad, at Denver, Colo., and equipping it with electric motive power. The above company is also building five miles of road at Nashville, Tenn., for the Nashville Electric Railway and Power Company, and will equip it with Brill cars and trucks and Rae motors.

Mr. E. S. Mendels has resigned the position of general manager of the Universal Arc Lamp Company, of New York, and will probably enter the banking business. This company's lamp has given universal satisfaction, and the company under Mr. Mendels' management has been kept very busy filling orders for incandescent stations. Mr. Mendels' friends will wish him every success in whatever he may undertake. L. H. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, April 4, 1891.

George T. Manson, of the "Okonite" Company, is wintering in Boston.

The Shaefer Electric Company is about to open an office in Boston in the New Exchange Building on State street.

George D. Hall, general manager of the Wainright Manufacturing Company, has returned from a two-weeks' trip through the West.

Governor Russell, of Massachusetts, accompanied by several members of his staff, paid a visit to the works of the Thomson-Houston Electric Company at Lynn last week upon the invitation of the winders. All the factories were visited, and a very pleasant time was had by all.

The Trolley in Providence, R. I.—The friends of the trolley system have gained their point in Providence, R. I., as permission has finally been given them to operate about four miles of road using the overhead wires, and work will begin at once on same. The council refused permission to equip the Pawtucket line in this way, on account of the narrow streets on that route and the large amount of traffic which they claimed would make such a line dangerous.

The Gould and Watson Company has recently come in possession of a bell form line insulator which had been hanging on the West End Street Railway, Boston, for two years and ten months. The insulator was removed to make a change in the curve where it was placed. Examination showed that it was sound as when first made without any deterioration whatever. Considering the high duty it was performing on an exposed position, and the heavy cross strain withstood, this is a remarkable record.

C. A. B.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY TRUST BUILDING, PHILADELPHIA, April 4 1891.

Baltimore, Md.—The ordinance of the North Avenue Electric Railway passed the Councils last week, and work will soon be commenced on the line.

Messrs. Hansom Bros., electrotypers, of 704 Sansom street, have purchased a 10 h. p. C. & C. motor, after subjecting it to a months' competitive test with various other motors.

Messrs W. S. Griffith & Co., of Philadelphia, have closed a contract with the Suburban Rapid Transit Street Railway Company, of Pittsburgh, Pa., for four 80 h. p. Mather generators.

Mr. J. W. Parker has contracted with the Schuylkill Electric Railway Company, of Pottsville, Pa., to furnish two 150 h. p. special railway engines, with boilers for same, as an addition to the present plant of the latter company.

Another New Electric Motor Car.—Messrs. Wright & Starr are now running, by permission of the Lehigh Avenue Passenger Railway Company, an electric motor car on that road. The car is constructed expressly for the purpose. It is said that the storage batteries are much lighter than those previously in use on that road, and are of a different construction.

Washington, D. C.—The Washington Electrical Conduit Company is laying five miles of conduit in this city for the United States Electric Light Company. This conduit has a capacity for eight miles of cable, which will be used for street and incandescent lighting. The city will be lighted throughout with electric lights, and all wires are being placed underground, running through conduits laid by the above company.

Pennsylvania Storage Battery Plant.—The Pennsylvania Insurance Company, of Philadelphia, Pa., has ordered from the Electro-Dynamic Company of that city 174 cells of the "15L" type, accumulators, with resistance cells, regulating switches, etc., complete, for lighting its building No. 517 Chestnut street, Philadelphia. The Pennsylvania company prefers storage battery lighting to operating an isolated dynamo plant.

Trolley System for West Philadelphia.—Mayor Fitler has appended his signature to the ordinance giving consent to the West Philadelphia Passenger Railway Company and the Philadelphia and Darby Railroad Company "to erect the necessary appliances and to operate the same by overhead electric wires on and over their plant and system west of the river Schuylkill." The ordinance requires that the work shall be under the supervision of the proper municipal officers, and that in case of the construction of an elevated railway over any of the streets on which the trolley wires run, the poles, etc., shall be removed and the wires strung to the iron work of the railway. W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, April 4, 1891.

A Pleasant Affair—Those universally popular young men, Messrs. Winston, Hoefer and Clark, of the Illinois Electric Material Company, were fully engaged last Wednesday in showing their friends around the new home of "Canvas Jacket" and "Bishop" wires at 158 Fifth avenue. The reception was purely informal, but none the less enjoyable on that account. Good wishes for the future continued success of the company were freely offered by all who were fortunate enough to be present.

Mr. Frank X. Ciott, formerly of San Francisco Cal., who has carried on a general agency business for eight years in that city in electric supply and railway material, has assumed the management of the rail department of the Electric Merchandise Company, of Chicago, which firm is now selling agent for the Tramway Rail Company, of Pittsburgh, Pa., manufacturers of girder, tram and tee rails, as well as general street railway equipments.

H. C. E.

CINCINNATI, O., April 4, 1891.

Niles, O., is to have a $10,000 electric light plant.

Crawfordsville, Ind., has just secured a new electric light plant.

Lancaster, O., has received its big new dynamo for electric lighting from the Thomson-Houston Company.

Damages Recovered.—Mrs. Mattie Duebler, of Lima, O., whose husband was killed by a live electric light wire, has recovered $3,500 damages against the Lima Electric Light Company.

The Cincinnati Edison Electric Company says it is going to invest a round million in its plant on Eighth street and in subways and wires, and will give the gas company monopoly, which absorbed all the other large electric light companies, a hard fight.

Railway Extension.—There is now an ordinance before the Cincinnati Council providing for the extension of the Newport (Ky.) and Cincinnati street railway and for installing an electric system of road. The new bridge across the Ohio will be completed this spring and will carry the electric road from Newport to Cincinnati.

The Covington (Ky.) Gas Company stockholders are credited with an attempt to get possession of the electric light plant in that city, but the gas men declare the electric company is not cutting into their business at all. The gas company has yet about 10 years to run on its monopoly of gas lighting in Covington. That period in itself is a little breathing spell, and its end is too far away to cause any particular flurry. And it was also stated that, if then, now, or any time intervening the gas company cares to engage in the electric lighting business, it possesses ample facilities, ways and means for doing so, better, in fact, than any other existing corporation.

The Mt. Auburn Inclined Plane Railroad Company has just given a mortgage for $150 0.0 on all its property, including its electric road, to the Columbia Fireman's and Trust Company, of Louisville, Ky. The Mt. Auburn electric road now extends five miles to St. Bernard, and it is proposed to go to Carthage, three miles farther. The hope is expressed by the company that it will keep on extending its tracks up Millcreek Valley, parallel with the C. H. & D. Railroad, until it has taken in Hamilton, 25 miles away. It would cover thus 12 or 15 large suburban towns, and, with Hamilton, would draw passengers from a population of not less than 40,000. It promises to be a wonderfully remunerative road.

OLYMPIA, Wash., April 1, 1891.

An Interesting Plant.—Mr. R. Fleming, who is representing the Edison General Electric Company, is now engaged in the construction of an interesting light and power plant. It is on what may be called a direct current transformation system. Primarily, power is derived from two 300 h. p. Victor turbines of the twin horizontal pattern, coupled direct to a line shaft, one at each end, and connected by means of friction clutches, so that the wheels can be connected together or run separately. From these are to be run arc, street railway, and power generators. This power station is situated at Tumwater on the falls of the Des Chutes River, a distance of two and a half miles from the city of Olympia. Here are to be placed, besides street railway and arc dynamos, two standard 500-volt generators, each of 50 kilowatt capacity, coupled in series. From these a circuit is run to a sub-station in the centre of the city, where current will be supplied to a 100 h. p. 1,000 volt Edison motor, which in turn is to drive standard low volt Edison machines on the three wire system for lighting the city. It is also the intention to run a neutral wire so as to enable motors for running printing presses, etc., to be supplied with current at a pressure of 500 volts. The arc apparatus is of the Edison latest style, and is giving excellent satisfaction. The arc machines have been running since Jan. 1.

ST. LOUIS, Mo., April 3, 1891.

Mr. M. B. Barr, St. Louis agent for the Edison General Electric Company, has secured the contract for the installation of an incandescent electric light plant of 3,200 lamps capacity for the large warehouse of the Samuel Cupples Real Estate Company of that city.

The St. Louis (Mo.) Electric Power Company has added a second 80,000 watt Edison dynamo and a 200 h. p. steam plant with a Russell engine to its installation. This company is now furnishing power for over 200 motors, ranging in horse-power from one-half to 15.

The Laclede (Mo.) Gas Company is negotiating for the control of the plant of the St. Louis Electric Power Company and will probably acquire that property. This will give the Laclede Company, with its $10,000,000 capital, the monopoly of the gas and electric light and power business in St. Louis, having recently acquired the Missouri Electric Light and Power Company's plant with 55,000 Westinghouse incandescent lights and the Municipal Electric Light Company's plant. Besides these it has its own incandescent plants of the Brush and Heisler system.

The St. Louis & Suburban Railway Company has commenced the work of widening the grade of its narrow gauge steam division preparatory to changing it to a standard gauge electric road. This division, from its terminus at Vandeventer avenue to Wells Station, about five miles, is a double track, and from there out to Florissant, about ten miles farther, it is a single track. The cable division, about three miles long, will be changed to an electric road, and when completed the two roads will be connected together, making a suburban line of about 18 miles in length. A branch will also be built to Forest Park from the Union Avenue Station, about a mile in length. The power house will probably be located at De Podimont, Mo., about half way out on the road.

SOUTHERN NOTES.

NORFOLK, Va., April 4, 1891.

Graham, Va.—A franchise has been granted to Walter Graham and others to construct an electrical railroad.

Shendun, Va.—A contract has been awarded by the Grottoes Company for the erection of a $20,000 electric light and power plant.

Ennis, Tex.—Parties are soliciting stock for a $65,000 company having in view the establishing of electric light works and an ice plant.

Navasota, Tex.—E. L. Bridges and others have been awarded the contract to erect an electric light plant to furnish street illumination.

Greenville, Tenn.—New machinery for incandescent lights will shortly be added to the plant of the Greenville Electric Light Company.

Griffin, Ga.—The Georgia Electric Light Company has petitioned the City Council for exemption from taxation for a term of five years.

Aransas Pass, Tex.—An electric light plant has been established by Messrs. Barlow and McKay, and is about ready to go into operation.

Mobile, Ala.—An electric railway line will be surveyed from Mobile to Florence, and it is estimated that a year will be required to complete the survey.

Morristown, Tenn.—Additional machinery sufficient to double the capacity of the Morristown Electric Light Company's plant will shortly be put in.

Selma, Ala.—The Selma Street Railway Company will be organized with a capital stock of $100,000, and the present road will be converted into an electric line.

Clarksdale, Miss.—The Clarksdale Water, Light and Power Company has been incorporated with a capital stock of $100,000 to establish an electric light plant in this place.

Lexington, Va.—It is stated that negotiations are in progress between the Lexington Development Company and others looking

to the establishing in that place of a plant for the manufacture of electric motors.

Tullahoma, Tenn.—It is stated that the electric light plant of Messrs. Bowlin and Gregg has been leased to W. H. McLemore, who represents a company which will operate it.

Newport, Tenn.—The Newport Development Company is reported to have perfected arrangements for the establishment of an electric light plant, together with other industrial enterprises.

Yazoo City, Miss.—The Yazoo Improvement Company, with a capital stock of $100,000, has been incorporated to establish a number of municipal improvements, among them being an electric light and heating plant.

Buena Vista, Va.—The Buena Vista Electric Light Company is getting estimates with a view of adding more machinery in order to increase the capacity of its electric light plant, which is at present insufficient for the demands of the place.

Martinsburg, W. Va.—A bill has been introduced and passed by the West Virginia Legislature empowering the city council to order an election in May for the purpose of deciding upon the issue of bonds with a view of establishing an electric light plant.

Middlesborough, Ky.—The Middlesborough Light and Power Company has perfected its plans for the erection of a new electric light plant which will have a capacity of 800 arc lights and 3,000 incandescent lights. The plant will be so arranged that this capacity may be doubled. V. N. B.

ENGLISH NOTES.

LONDON, March 25, 1891.

Proposed Electrical Exhibition at the Crystal Palace.—Encouraged by the remarkable success of the St. Pancras Vestry Electrical Exhibition, the directors of the Crystal Palace propose to hold a big electrical exhibition there in the coming autumn. The exhibition which was held there in 1882 marked an epoch in the history of electric lighting.

Telephonic Trunk Wire Development.—The success of the London-Paris telephone trunk wire has given rise to considerable activity in telephone circles. According to the Brussels correspondent of the *Times*, the question of establishing telephonic communication between London and Brussels is under consideration. The submarine cable which would be necessary for this line, if run direct, would be of considerably greater length than the one just laid. Berlin and Vienna are also shortly to be placed in telephonic communication with each other.

Municipal Electric Lighting.—Some time ago the gas committee of the Aberdeen Town Council issued circulars to the larger gas consumers asking whether they would be likely to adopt the electric light. The Aberdeen Town Council is, however, the owner of the municipal gas works, so they carefully explained in the circular that the cost of electricity as compared with gas was about as 4 to 1. This pressing invitation to adopt the electric light was responded to in an even more pressing manner, the opponents of electric lighting being to its advocates in the ratio of 40 to 1. The Town Council now magnanimously propose to permit a private company to come into this highly encouraging district.

Accident at an Isolated Installation in the City.—A curious accident occurred on Thursday last in connection with an isolated plant in the city. It was suddenly noticed that the light had become extremely unsteady and the electrical engineer in charge went down to the engine room to ascertain the cause. On arriving there, he found the two employés lying on the floor insensible. The engineer in charge endeavored to restore them to consciousness, but was himself soon overcome, the cause being gas escaping from the gas engine driving the dynamos. Shortly afterwards, Mr. Frank King, of the Electric Construction Corporation, happened to go in and found all three insensible on the floor, and in endeavoring to restore them he himself became seriously affected. Finally, however, the alarm was given and a rescue effected. The sufferers (one of whom is reported as being in a very serious condition) were removed to the nearest hospital.

Telegraphy Extraordinary.—The great snowstorm which recently visited this country was felt most severely in the western counties of Cornwall and Devon, where the land lines were down in all directions, and snowed up trains were as plentiful as blackberries in September. One result of this was that cablegrams arriving at the Eastern Telegraph Company's station at Porthcurno could not be transmitted to London in the ordinary way, and a number of important messages accumulated. One London firm, knowing that a message for it was snowed up in Porthcurno, dispatched a messenger by special train with instructions to have the message wired to London, via New York. The bulk of the cablegrams, however, were transmitted to London by Malta and Marseilles, a distance of more than 9,000 miles, and over this enormous length of submarine, subterranean and aerial line, nearly 1,600 messages were transmitted by hand in 24 hours. Taking all things into consideration this may well be considered a remarkable telegraphic feat.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Books for Beginners.—What is a good list of books for me to read in beginning the study of electricity? I have only a common school education, and am trying to learn a little about electricity by myself. E. K. N.

Perhaps Prof. S. P. Thompson's elementary book on "Electricity and Magnetism" is as good as any to begin with. The mathematics may trouble you a little, but it is worth your while to study it thoroughly and look up the points that puzzle you. The same author's little book on "Dynamo Electric Machinery" will interest you, and after that you would do well to read Fleming's "Short Lectures to Electrical Artisans."

News of the Week.

THE TELEPHONE.

Kansas City (Mo.) Telephone Lines.—The telephone company has completed its survey of the streets along which it contemplates placing its wires underground. It has prepared plats of all the down town business streets, showing all the surface and underground improvements, and also maps showing the alleys which it contemplates using, so that it is ready at any time to begin the work.

Electrical Industries in South America.—Late advices from Venezuela state that the telephone business is growing rapidly in South America. Caracas now has 1,000 subscribers, 300 of whom have been secured since March, 1890, when the Inter-Continental Telephone Company sold the plant and business to English capitalists. A census was recently taken at Caracas showing the population to be 70,000. (In 1881 it was but 60,000.) The Mutual Telephone Company, of Venezuela, announces that it will supply telephonic service with improved instruments for £5 10s. per annum.

THE ELECTRIC LIGHT.

Mt. Carmel, Ill., has contracted for the erection of a municipal arc light plant of a capacity of 30 2,000 c. p. lamps.

Wellsburg, W. Va.—The electric light plant was started for the first time last week, and the consumers are well satisfied.

Denver, Col.—The Denver Highlands Electric Company has contracted with F. P. Arbuckle to construct its plant, which will be commenced in a short time.

Syracuse, N. Y.—The Syracuse Electric Light and Power Company has been awarded the contract for lighting the city with 500 lights for a period of five years.

The Portland City (Or.) trustees have awarded a contract for lighting the streets for the ensuing year to the Willamette Falls Electric Light Company, at a monthly rate of $9.27 per light.

Milwaukee (Wis.) City Lighting.—A committee of the Board of Aldermen, of Milwaukee, Wis., is now in Pittsburgh, Pa., on a tour of inspection, with regard to municipal lighting.

Waukegan, Ill.—The electric light plant started up last week on trial and worked with great satisfaction. An addition will soon be made to the plant and the entire town will be lighted by arc lamps.

The Oregon City (Ore.) Electric Company lights the streets with 450 Edison incandescent lights. The business has outgrown the present machinery, and it is contemplated to enlarge the plant in the near future.

Wayne, Pa.—The electric light company is pushing its plant very rapidly, and the wires on the streets will probably be stretched next week. Several houses in town are now being wired. A number of West Chester men are working on the enterprise.

San Francisco, Cal.—The Electric Improvement Company has closed a contract to furnish the Palace Hotel with an additional 1,000 incandescent light plant (Slattery system). There will be eventually four or five thousand incandescent lights in the Palace Hotel.

San Jose, Cal.—For some time past the Electrical Improvement Company has had great difficulty in carrying out its lighting contract with the city, having been prevented by the San Jose Light and Power Company from making use of the principal tower in the city. The injunction has been dissolved, however.

The Milwaukee (Wis.) Electric Light and Power Company, which operates two 750-light Westinghouse alternating current dynamos and two 40 light arc machines of the Western Electric Company, will add to the installation next week a 1,500 incandescent light Westinghouse alternating current dynamo. The company recently moved into a handsome suite of offices.

Change from Arc to Incandescent Lights.—An interesting change in a plant consisting of an old-style Weston 12 coil 10-light arc machine, so that it might be used to supply current to 40 incandescent lights, has just been made by Mr. Harry Alexander, of this city, at the iron works of J. B. & J. M. Cornell. The old machine was series wound, of 6,000 watts capacity, giving 20 ampères at 300 volts and running ten 30-volt arc lamps. The Bernstein series lamps and plain sockets were used to replace the arc lamps and these are run in multiple series, five branches in all, with eight lamps in series in branch, making 40 lamps in all. The lamps are four ampère 50 c. p. each, are run in double rows in each of the four sections in the factory, each section being 50 × 250 and 15 feet high, making the lamps on the average about 25 feet apart, each lamp being supplied with a 19-inch enameled reflector, which throws a bright steady light in all directions over the full area. The lamps are easily controlled by a safety branch board at the main line.

THE ELECTRIC RAILWAY.

Messrs. F. W. Little & Co., of Sioux City, Ia., representing a syndicate recently formed, have bought out several street railroads in Lincoln, Neb., amounting to 37½ miles, and J. F. Barry & Co., of William street, New York, have secured the contract to equip the consolidated roads at once with an electrical system; the station equipment will be by the Thomson-Houston Company, and the cars will be divided in motor equipment between the J. H. Short and Rae companies.

The Short Electric Railway Company has recently closed contracts with the Lincoln Street Railway Company for 20 car equipments and 20 standard motors, and is to place a large number of the new gearless motors on the Lincoln lines when this order is installed. This company has also closed a contract with the West End Street Railway Company, of Rockford, Ill., for five miles of overhead construction, three car equipments, six standard motors and an 80 h. p. generator, besides having received its third order from the S. Covington and Cincinnati Street Railway Company for two more 125 h. p. generators, 16 standard motors and 8 car equipments.

The Dahl Motor Anticipated.—Mr. J. F. McLaughlin, of Philadelphia, sends us the following: "In a recent issue of THE ELECTRICAL WORLD there is an article giving a description of a street car motor, under the head of 'The Dahl Motor.' Upon a perusal of this article one would be under the impression that the device was new, but such is not the case, as I designed the same apparatus and filed an application for a patent for it in the summer of 1885. I was referred to an English case, and the result was that my application was rejected. I write this simply to show that the designer of the Dahl motor has been anticipated, not only by myself, but by others."

LEGAL NOTES.

Brush vs. American Arc Light Company.—The Brush Electric Company, of Cleveland, has begun suit in the United States Circuit Court of New York against the American Arc Light Company for alleged infringement of patents. An injunction and accounting is asked for.

Injury from Electric Light Wires.—In a suit recently brought in the Boston Superior Court against the city for damages in behalf of four small boys who were severely injured by straggling electric light wires while playing in the street, the city brings up the question as to whether or not the boys were injured as "travelers on the highway."

Patents for Feeding Devices for Carbons.—Letters patent No. 147,8.7, granted Jan. 24, 1874, to Matthias Day for an "improvement in electric lamps" were for a device by which the upper and lower carbon holders of an electric lamp, each arranged to carry two or more carbons, are caused to be fed towards each other in such relations that the arc will be established and burn between one pair of carbons for a short interval, and then shift to the other pair, so that the arc shifts from one pair to the other until both are consumed; but the carbons carried by each carbon holder move together. This patent is not infringed by letters patent No. 219,208, granted Sept. 2, 1879, to Charles F. Brush, for a device whereon the upper carbons are separately dissimultaneously from the lower, whose holder is fixed so that the arc is established between the pair last separated, the upper carbon of which is fed towards the lower until they are entirely consumed, and then the arc is established between the other pair, which burns in the same way. (Seely v. Electric Light Co., Circuit Court of the United States, Northern Division of Illinois, 44 Fed. Rep., 419.)

PERSONALS.

Dr. F. D. Andrews, at Rochester, N. Y., last week, gave a most interesting lecture on "Electricity" at the meeting of the Epworth League.

Mr. Edward Higgins, of Buffalo, N. Y., formerly of the Thomson-Houston Electric Company, is now with the Short Electric Railway Company.

Mr. S. W. Atterbury, of Litchfield, Ill., late of the Westinghouse Electric and Manufacturing Company, has taken a position with the Short Electric Railway Company.

Mr. C. J. Van Meerbeke, of East Stroudsburg, Pa., who has up to the present time been engaged in the electrical supply business at that place, has now given up his business and accepted a position with The E. S. Greeley & Co. of this city.

Mr. Joseph J. Mitchell, of Lynn, Mass., assistant superintendent of the Thomson-Houston Electric Company, received a very pleasant surprise party from a number of the employés last week on the occasion of his thirty-third birthday anniversary.

Mr. William Cassils, president of the Federal Telephone Company, of Montreal, Can., left last week for the south of France, where he intends to spend the next few months. The members of the Thistle Curling Club, of which he was an enthusiastic member, gave Mr. Cassils a rousing send off at the Bonaventure Depot.

MISCELLANEOUS NOTES.

Electrical Reduction Works for Colorado.—A syndicate of capitalists is to erect electrical reduction works at Glenwood Springs, Colo. It has been decided to build a plant also at Canon City, which will cost $250,000. Some 10,000 tons of coal have been contracted for at 25 cents per ton. Zinc ores will be treated and other ore of a refractory character. The land will probably be secured on the Roaring Fork tract.

Gun Sighting by Electric Light.—In Tampa Bay, Fla., last week, in experiments of gun firing by night, a target 24 feet by 12 feet was hit ten times out of thirty by the aid of the search lights, and the score is considered excellent, as another ship fired more shots and missed all times. Target practice with small arms on Egmont Key has been the order of the day for a week past, and some good scores have been made. During the week one of the seamen gunners has been in the diving apparatus examining the bottom of the Boston by means of incandescent light.

Industrial and Trade Notes.

Messrs. W. C. McIntire & Company have been appointed agents for Philadelphia and vicinity for the Taylor primary battery.

C. R. Vincent & Co. have secured the contract for the complete installation of a 500 h. p. steam plant for the West End Street Railroad, Lancaster, Pa.

The Excelsior Electric Company is very busy filling orders for its new alternating current motors of 52 and 100 volts respectively, for use in connection with fan service.

The Perkins Lamp Company, of Manchester, Conn., is still very busy. During the past few days heavy orders have been received, and the prospect is of a very successful year.

Mr. P. W. Mitchell, formerly of the North American Construction Company, is now with Messrs. W. H. Gordon & Co., and will devote his time to the supply and specialty department.

The Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., will soon increase its number of workmen from 300 to 1,500. From this latter number the employés have been temporarily reduced.

The Barrlett Electric Company have just brought out a new alternating fan motor of 50 and 100 volts, which has many valuable features. This company is now operating motors at 10-12 Ann street, 113 John and 29 Beaver street, this city.

The Cincinnati Corrugating Company recently received a rush order for a number of corrugated galvanized iron arches, and the sheets were rolled, annealed, pickled, galvanized, corrugated, curved and shipped within two days from receipt of the order.

The United States Mineral Wool Company, of 2 Cortlandt street, New York, is meeting with great success among electric light and power stations with the U. S. metallic pipe covering. The filling material of this appliance is rock wool, one of the best of non-conductors of heat.

The Electric Merchandise Company, of Chicago, Ill., has issued "Supplement No. 1" to the general catalogue of 1891 of the company. The supplement puts forth the merits of the Ellis oil filter. The efficiency of this separator has long been recognized by electric light superintendents.

The Triumph Compound Engine Company reports that it has just booked the second order of the Butte & Boston Mining Company through its agents, Fraser & Chalmers, for an engine for electric lighting purposes, the mining company expressing itself as well pleased with the first engine furnished.

The Garvin Machine Company, manufacturers of machinery and machinists' tools, of Laight and Canal streets, New York City, has issued a new price-list for 1891, which contains many handsome cuts of the Garvin apparatus, and the machinery shown at the prices given in the last price list must satisfy all buyers.

Storage Batteries on the Pacific Coast.—Mr. Robinson, of the Ryland-Robinson Electric Supply Company, of San Francisco, Cal., recently made an extended eastern trip. He secured the Pacific coast agency of the Consolidated Electric Storage Company

(the Julien system). A company will be formed at once to push the business.

Battery Zincs.—Supply dealers often desire to purchase special forms of battery zincs or to have zinc plate cut to order. Mr. Edwin L. Edes of Plymouth, Mass., makes a specialty of this class of work and also of supplying the regulation type zincs for carbon, Bunsen, Fuller, Crowfoot, or Leclanché batteries and cylinder and wheel zincs.

Mr. W. S. Estey, of 71 Fulton street, New York City, the manufacturer of the well-known S. T. wire goods, makes a specialty of superior wire cloth of brass, copper, iron and steel of all sizes of mesh. The S. T. wire cloth is used by many of the electrical parent companies for resistance box netting, instruments, armature protectors, etc.

Messrs. Laing, Wharton and Down, electrical engineers and contractors, of 82A, New Broad street, London, England, have issued a most complete catalogue and price-list of accessories and fittings for electric light plants, which abounds with superior cuts of supplies and station plans, making it one of the most efficient catalogues we have seen this season.

The Milliken Patent Poles need no better advertisement than the many installations of the same throughout the country. Messrs. Milliken Brothers, however, keep constantly to the front in calling attention to their installation work, and the last catalogue issued by this company contains much information for electrical railway constructing engineers.

Large Belts.—The Underwood Manufacturing Company, of Tolland, Conn., is now making two belts for the Chicago City Railway Company, each of which is 200 feet in length and 62 inches in width, and contains slightly over 1,000 square feet. These belts are somewhat larger than those in the electric light station at New Orleans, to which attention has recently been called as the largest in the world.

The Electric Secret Service Company, of 45 Broadway, New York City, now controls and operates the patents of E. R. Gill, Jr., A. A. Watch and others upon automatic electric signal controlling apparatus and electric combination locks. This company has met with many infringements of its rights and has instituted suits against the infringers, and it is expected that the cases will soon be decided in its favor.

Canadian Agency of the Crocker-Wheeler Motor Company.—In a note recently published in THE ELECTRICAL WORLD it was incorrectly stated that Mr. Frederick Nicholls had been appointed the Canadian agent of the Crocker-Wheeler Motor Company. Mr. A. J. Corriveau, of Montreal, has the agency for these motors in Canada, and will energetically push the sale of them in the territory for which he has been appointed.

The Viaduct Manufacturing Company has just produced a new push button that will interest the bell-hangers. One of the greatest annoyances incident to the use of electric bells has arisen from failure of the battery and the persistent ringing sometimes indulged in by disgruntled guests at hotels. This button is intended to save the battery, and the more it is pushed *the more it don't ring.* Hotel people especially will appreciate this feature.

The Jersey City Smelting Works, of 105-111 Plymouth street, Jersey City, N. J., has issued a circular calling attention to its well known fuse-wire, and giving a most complete table of the sizes and carrying capacities of the fuses, and also showing the number of lamps which can be carried of 3, 3.5, 4, and 5 watts efficiency. The above company also manufactures various sorts of solder, babbitt metal, aluminium sheet, wire, tubing and castings.

The Riker Motor Company, of Brooklyn, N. Y., continues to do a very large business. The company's motors from 10 h. p. down to 5 h. p. run at the very slow speed of 600 revolutions, while those from 3 to ½ h. p. only make 700 revolutions per minute. This slow speed saves wear and tear of the machines, and the work done by them is remarkable. Mr. Riker, of this company, was one of the first a few years since to suggest the gearing direct of motors to the axle for street-car work.

The Noye Engines.—The Edison Illuminating Company, of Detroit, Mich., has contracted with Fairbanks, Morse & Co., of Chicago, Ill., for a 400 h. p. non-condensing, tandem, compound engine, built by the John T. Noye Manufacturing Company, of Buffalo, N. Y. This engine will be an exceptionally fine one of the "B" type, suitable for heavy duty. Attached to it will be two of the new pattern Edison machines, which will be among the first of this size built by the Edison Company.

Mr. W. H. Gordon, of Messrs. W. H. Gordon & Co., 115 Broadway, New York, has, on account of the growth of business in Simplex wire, secured a separate office in Room 32, the same building, and will hereafter act as New York agent of the Simplex Company. Parties purchasing wire imagine frequently that they must go to the office of the parent company to get the lowest prices, but Mr. Gordon as the accredited agent of the Simplex Company will be able to supply all wants at factory prices.

Mr. A. B. Laurence, 225 Pearl steeet, New York, is, as usual, making large sales of the Shultz rawhide belting, some of his late installations being in the new building of the Central Railroad Company, corner Liberty and Washington streets, six belts, four belts 11-inch, and two 9-inch; Stokes building, two 11-inch belts; Times building, one 11-inch belt—all for electric light plants; the belting and pulley covers for Commodore Gerry's new yacht "Electra," and five 18-inch and six 10-inch belts for the new factory of Chas. E. Rogers & Co., South Brooklyn.

Salt Lake City, Utah.—Mr. William G. Lawrence is at present employed as inspector for the Salt Lake Electric Light, Power & Heating Company, and is doing much to improve the quality of the installation work. The Pacific Insurance Union seems desirous of obtaining the best work that can be had in providing for the safety of buildings, and the electric light company is anxious to give the best of satisfaction. It is said that "some of Capt. Brophy's work among the construction companies doing business in the far West would do them good."

The Chandler & Taylor Company, of Indianapolis, Ind., has recently put up a large boiler shop for the manufacture of stationary and portable boilers for use in connection with its large and growing engine trade. Many of this company's engines are now in use in electric light stations throughout the country, and are invariably giving satisfaction. The rapid development of the business of the company has made several additions to its equipment necessary, and preparations are now being made for taking care of a larger trade during the coming season than any heretofore experienced in the history of the establishment.

Messrs. Keuffel & Esser, of Fulton street, New York City, well known in every drafting room throughout the world, have always kept at the very front of the ranks in the production of superior drafting instruments, and it would be indeed difficult to find anything lacking in the stock list of the above company. Messrs. Keuffel & Esser have now placed upon the market a reservoir ruling pen, and, although the name explains in a way what the pen is, still, as most pens of the kind heretofore have had many objectionable features, it may be necessary to say that the latest "K. & K." reservoir pen is perfectly practical and is intended to save the draftsman much labor.

A complete catalogue has just been issued by the Central Electric Company, of Chicago, containing illustrations and descriptions of the apparatus for which it is the Western agent. The book is supplemented by a list of American and foreign works on electricity and its applications; rules and regulations of the N. E. Insurance Exchange, and the Boston Fire Underwriters' Union, the New York Board of Fire Underwriters, and a number of tables which will be found useful in the every-day practice of the electrical workman. The catalogue contains about 300 pages and is bound in a substantial form for shop or office use.

An Artistic Catalogue.—The supply house of Alexander, Barney & Chapin, of this city, has just published for the use of its patrons a very elaborate and at the same time useful and artistic catalogue, containing illustrations and descriptions of a large number of electrical supplies, together with price lists and much useful data regarding the different pieces of apparatus for which this company is acting as agent. The volume, for such it really is, contains no less than 224 pages, and is inclosed in a very handsomely designed cover. The engravings on both the front and back of the cover represent the company's trade-mark very neatly combined with appropriate pieces of electrical apparatus.

Messrs. Albert and J. M. Anderson have entered into an agreement with the Engineering Equipment Company, of 73 Cortlandt street, New York, by which the latter company becomes the representatives of the Anderson line materials, which include the well-known "Boston trolley," the trolley wire hanger, the "Etna" insulators, and all other materials for the equipment of electric roads which are manufactured by the Messrs. Anderson. The Engineering Equipment Company is the authorized agent for the sale of these line materials, and the trade will be given the best facilities in all dealings they may have through this agency. The Engineering Equipment Company, which is now in temporary quarters, will remove during April to its new offices in the Central Building, foot of Liberty street, New York.

The Grady Alarm Clock, manufactured by T. H. Grady & Co., of 263 Fulton street, New York, has many important advantages that will make it popular in the trade. The electric bell, battery and clock movement are all inclosed in a finely finished nickel plated case, making it as compact and portable as the ordinary mechanical clock. One of the valuable features is its adaptability to business purposes; for instance, a business man may make an appointment and set the alarm for that hour, and when the time arrives the alarm rings and he is reminded of the engagement, or he can use it as a call bell by simply touching the contact pin to any part of the case. The clock can be set for any hour and as many times throughout the day as desired. No winding up is required. To operate some of the electrical alarm clocks now in the market it is necessary to run wires from the clock to the vibrating bell, but the Grady bell requires no wiring.

The Rodney Hunt Machine Company, Orange, Mass., reports business unusually good for the time of the year. The company is at present making, or has recently installed water wheel plants for electric lighting for the following parties: Fort Wayne, Ind., Water Power Company, 1,000 h. p.; People's Electric Light and Power Company, Oswego, N. Y., 500 h. p.; Farmington River Light and Power Company, Hartford, Conn., 650 h. p.; Manchester Electric Light Company, Manchester, N. H., 450 h. p.; Electric Machine and Power Company, Woonsocket, R. I., 175 h. p.; Electric Construction Company, Greenwich, N. Y., 300 h. p.; Lebanon Electric Light Company, Lebanon, N. H., 175 h. p.; Gates Electric Light Company, West Lebanon, N. H., 75 h. p.; Gautemala, C. A., Electric Light Company, 260 h. p.; Nonotuck Silk Company Electric Power Plant, Leeds, Mass., 175 h. p.; A. E. Call, San Salvador, C. A., 100 h. p.; Manufacturing Investment Company, Madison, Me., electric plant, 75 h. p.; Middlebury Electric Light Company, Middlebury, Vt., 125 h. p.; Springfield Electric Company, Springfield, Vt., 125 h. p., and 1,500 h. p. for other purposes.

The Stilwell & Bierce Manufacturing Company is the proprietor of one of the largest machinery establishments in the West. This enterprise dates back to 1866, and was commenced in a small way by G. N. Bierce and E. R. Stillwell, and this moderate start formed the nucleus from which was developed the enormous business now operated by the Stilwell & Bierce Manufacturing Company, which was incorporated in 1870. The shops occupy a frontage of nearly 1,000 feet, with large rear additions. The facilities of the works have recently been nearly doubled in capacity. The factory is operated by water power with steam power in reserve, and a force of about 350 skilled workmen are here given lucrative employment. The establishment is divided into three general departments, each manned by an accomplished engineer with a suitable force of assistants. These departments cover the manufacture of the Victor turbine water wheels, both vertical and horizontal, in great variety of styles and sizes, besides power connections of all kinds and devices for heating and purifying the feed water for steam boilers, prominent among which are Stilwell's exhaust heater and filter combined, of which over 5,000 are in daily use, and Stilwell's live steam purifier.

Vulcabeston.—In the manufacture of vulcabeston certain amounts of asbestos and rubber are placed together and the rubber is thoroughly cut with naphtha, so that every fibre of the asbestos is covered with the solution. It is then molded from five to eight times the thickness of the intended finished piece, and allowed to cure for such a time as is necessary, when it is pressed to about one-half the former thickness. It is then taken from the press and again allowed to cure until on examination the piece is found in proper condition to finish, when it is placed in hydraulic presses and forced to the thickness desired. In making insulating pieces after the final pressure each piece is put into a vulcanizing mold, which is exactly the form required for the finished insulation. These molds are then placed in a steam press of from 350 to 1,000 tons pressure, and vulcanized under this pressure. When taken from molds after such vulcanization it is found that the pieces will retain their exact shape and size, will not contract or expand from change of temperature, will not warp, and are extremely strong and tough. Vulcabeston is said to be one of the best composition insulators known in the market. The process of manufacture requires the handling of each piece from seven to fifteen times to bring it to the proper standard. The Crocker-Wheeler Motor Company has adopted this insulation for covering the cores of the field magnets of its motors.

The Woodbridge & Turner Engineering Company has been organized as successor to the firm of Woodbridge & Turner, of this city, with Wm. S. Turner as president, Geo. A. Bell as vice-president, and J. Lester Woodbridge as secretary and treasurer. The company will occupy offices at 47 Times Building, New York City, and to it will be turned over all new business of the firm, together with its entire stock of tools, supplies, apparatus, etc. It is the purpose of the organizers to extend the scope of the business of the firm in electric railway and electric light engineering. The company will conduct a consulting and constructing engineering business, furnish plans, specifications and estimates, supervise construction, and enter into contracts for the equipment of electric railways and electric light plants, in full or in part, including steam plants, line construction, track building, generators, motors and cars. The company will be conducted under the same management as the old business, which was established with the building of the first commercially successful electric railway in the United States, and the organizers feel that they bring to the company, together with their force of co-workers, a knowledge and experience equal to the demands of the business which has grown so remarkably. It is the purpose of the management to retain the high standard of workmanship in all departments which it has heretofore been the endeavor of the firm of Woodbridge & Turner to sustain and to merit a continuance of the good will and confidence which has hitherto been reposed in them.

English Megohm Plates.—With the advent of the English megohm plates a thoroughly handy, convenient and reliable megohm resistance is available at a much smaller cost than 1-10 megohm wire box. The portability of the megohm plates will be best appreciated upon taking into consideration the measurements and weight of the instrument. It is only nine inches in length by seven in width, and exclusive of the binding posts, two inches in height. The whole weight of the instrument is about three pounds. Its use is very well described in the following extract from a paper by Richard W. Davids, read at the meeting of the Electrical Section of the Franklin Institute, March 10, 1891: "It is designed to take the place, at a small cost, of expensive and cumbersome wire resistance having approximately equal values, or the use of varying shunts, different electromotive force, and the wire resistances in ordinary use in measuring commercially the insulation resistance of cables, air lines, etc., by means of proportional deflections on a sensitive galvanometer." As evidence of the permanent character of the instrument it is stated that Mr. David Brooks, of Philadelphia, has had one of these instruments in use for ten years without any perceptible variation in the resistance, he having had it tested frequently at his laboratory throughout this period of time. This instrument, though comparatively new in this country, is well known in England, where it has been in operative use for a number of years. It consists of a conductor of high resistance material, baked into plates of glass, which thoroughly protect the current from moisture. The resistance of the instrument is not materially affected by atmospheric changes of temperature. These standards range from one to five megohms, being calibrated as near to the unit as practicable. The definite resistance is marked on the face of each instrument in legal ohms. The plates are mounted in polished mahogany cases with hard rubber tops and convenient binding posts. This instrument is placed upon the market in this country by the E. S. Greeley & Co., of New York.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

Incandescent lighting of stores, offices and dwellings is so prominent a feature of one of the large prosperous and growing cities of the West, where wealth and artistic sympathies insure the installation of handsome fixtures, that the local lighting companies are now supplying current to nearly 35,000 incandescent lamps. In that city is a well-established gas and electric light fixture business, with new and well selected stock and finely appointed show rooms, which the owner would like to dispose of solely on account of ill health. A thorough investigation will repay any one interested. Address, Studio, 167 Times Building, New York.

"Printers' Ink" is to the advertiser what THE ELECTRICAL WORLD is to the electrician and mechanic devising specialties to meet the demands required by improvements in electrical fields, full of pithy, pointed paragraphs that stimulate thought and suggest ideas easily elaborated and converted into current coin; crisp, concise paragraphs gleaned from the experience of broad gauge, successful advertisers who generously warn others how to avoid stumbling blocks in the pathway of advertising life, and containing suggestions relative to the preparation and attractive presentation of advertisements, that if carried out in the proper spirit will show results in securing customers and cold cash calculated to create consternation at the counter of the competitor who never reads "Printers' Ink." A majority of our 50,000 readers will find it profitable to send to Geo. P. Rowell & Co., 10 Spruce street, New York City, for this warmly welcomed little weekly.

West Shore Railroad (N. Y. C. & H. R. R. R. Co., Lessee).—This picturesque route for business and pleasure travel leading to and from New York City, is a superbly built, magnificently equipped, double-track, steel trunk line to and from the West. This substantially built line, traversing, as it does, the west shore of the historic and world famed Hudson River, skirts the foothills of the Catskill Mountains and forms the only all rail route to and from the Catskill Mountain regions, passing through the beautiful Mohawk Valley. Speed, comfort, safety, picturesque scenery, combined with all modern improvements in railroad service, have made the West Shore deservedly popular, as well as traveling a luxury. By this route three fast express trains are run daily in each direction between New York, Kingston, Newburgh, Albany, Utica, Syracuse, Rochester, Buffalo, Niagara Falls, Toronto, Detroit, Chicago, St. Louis and the West. Wagner palace sleeping cars are attached to these trains and run without change between points named. Wagner buffet sleeping-cars between New York and Toronto, without change, are run exclusively via the West Shore route. The West Shore, in connection with the Fitchburg Railroad, is also the shortest line between Boston and Chicago. Through sleeping-cars are run between Boston and Chicago and between Boston and St. Louis. The only line by which drawing-room cars and buffet smoking cars are run through to the heart of the Catskills. During the season of summer travel fast Catskill Mountain express trains are scheduled. Attached to these trains are Wagner drawing-room cars and buffet smoking cars, which run through without change between Philadelphia, Jersey City, New York and Catskill Mountains. Saratoga Limited express trains are also run by the West Shore during the summer season, and have drawing-room cars and buffet smoking cars attached which run through without change between Washington, Baltimore, Philadelphia, Long Branch, Jersey City, New York, Saratoga and Caldwell, Lake George. The buffet smoking cars with revolving chairs are a special feature of the splendid service on the West Shore. Special trains are also run between New York and New Paltz during the summer season for the accommodation of travel to and from Lakes Mohawk and Minnewaska, Shawagunk Mountains and all points in the Wallkill Valley. The connection in Jersey City station with the Pennsylvania Railroad will be appreciated by travelers to and from the south and the resorts of Central New York State, as the long transfer through New York is thereby avoided. Passengers and baggage from Brooklyn are taken direct from foot of Fulton street by annex boat to Jersey City. Tickets via West Shore, can be purchased at all ticket offices of all connecting lines, and they are sold and baggage checked through to destination from all stations of West Shore Railway. For time table and information address C. E. Lambert, General Passenger Agent, No. 5 Vanderbilt avenue, New York.

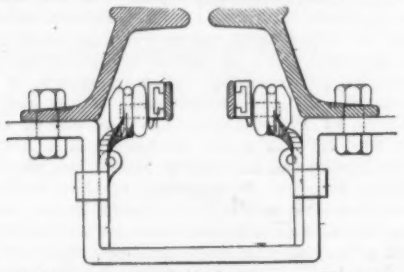
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 31, 1891.

449,106. Telephone Circuit and Apparatus; John J Carty, of New York, Assignor by mesne assignments to the American Bell Telephone Company, of Boston, Mass. Application filed Aug. 16, 189 . A multiple station telephone circuit, a call-bell magnet of relatively high resistance at each station included in a branch circuit uniting the two sides of said telephone circuit, and a generator of electricity for sending calls at each of said stations, adapted when operated to be connected between the two sides of said telephone circuit in multiple arc with the call-bell magnet.

449,153. Hangers for Electric Lamps; Horatio A. Foster, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Aug. 1, 1890. The combination of the hanger for electric lamps, having one end fastened to a building or like support, and provided with an insulated point of attachment for the lamp with a guy wire or wires attached to and sustaining its outer end by means of one or more insulators.

449,168. Art of Covering Electric Wires; Thomas W. Norman, of Boston, Mass. Application filed April 29, 1890. The art of covering insulated wire, etc., with lead or other suitable metal, which consists in taking a flat strip or ribbon of the metal,



No. 449,196.—ELECTRIC RAILWAY CONDUIT.

scarfing the edges thereof, feeding the wire and metallic covering-strip forward, continuously inclosing or encircling the former in the latter during the forward movement by a series of differential steps gradually inclosing the covering over the wire and soldering the meeting scarfed edges of the covering.

449,174. Telegraph-Transmitter; Harry G. Robbins, of Minneapolis, Minn. Application filed Nov. 29, 1890. A telegraph-transmitter, having a plunger with a spindle adapted to move therein, and through the medium of which said plunger is adapted to be moved, a contact-stud provided in said plunger and adapted to make contact with said spindle when said spindle is moved positively, a contact brush or point extending from said plate, and a secondary plate or series of plates arranged in the path of said brush and adapted to make contact therewith when said plunger is operated, whereby said spindle forming one terminal of an electric circuit and said secondary plates the other terminal, said circuit is closed upon the operation of said plunger.

449,180. Telephone Sound-Transmitter; Adam E. Schatz, of New York. Application filed March 1, 1888. A horn-shaped sound conveyer for telephones provided with an opening in its convex side near the large open end thereof.

449,186. Thermo Electric Battery; John N. Webb, of Birmingham, Ala. Application filed July 19, 1890. A portable thermo-electric battery, the ends, plates, or parts of which for heating or cooling are of relatively great size to the intermediate connector, which is a suitable flexible connection.

449,188. Electric Switch; William White, of London, England. Application filed Dec. 3, 1889. In an electric switch stepped contact plates having the edges of their steps sloped downward in combination with correspondingly stepped contact arms and a shaft moving longitudinally and having a friction head or shoulder.

449,196. Electric Railway Conduit; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed March 5, 1889. An electric railway conduit having a transverse yoke and slot rails with a clamp having clamping faces engaging the yoke and an insulated supply conductor attached to the clamp. (See illustration.)

449,197. Electric Motor Truck; Francis O. Blackwell, of New York, Assignor to the Thomson-Houston Electric Company of Connecticut. Application filed Aug. 31, 1889. The combination, with a driven axle, of a motor having a bearing thereon and a single supplementary supporting bearing on the opposite axle.

449,206. Electro Magnetic Device; Moses G. Crane, of Newton, Mass. Application filed July 16, 1888. The combination of an electromagnet and its armature pivoted to vibrate back and forth before the poles of the said magnet and normally when the said magnet is demagnetized remaining in an intermediate position between its extreme forward and backward positions, combined with a main circuit through the said magnet and a local circuit through the said magnet, and a circuit closer in said local circuit, arranged with relation to said armature, whereby the said circuit closer in the local circuit remains open when the armature is in its normal intermediate position and is closed when the armature moves backward beyond said normal intermediate position.

449,209. Electric Fuse; Geo. F. Curtiss, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed June 20 1890. In an electric fuse, the combination consisting of a fuse-wire, with an inclosing tube having a bore of such diameter that the wire fills the tube with slight, if any, clearance for the purpose of causing the sudden expulsion of the wire when melted. (See illustration.)

449,226. Guard for Electric Railway Trolleys; Andrew W. Mitchell, of Boston, Mass. Application filed June 23, 1890.

No. 449,209.—ELECTRIC FUSE.

The combination with a trolley wheel of two arms, each having a flange extending over the wheel and provided with a slit or opening in line with and for the rim or edge of the wheel to project through.

449,227. Electrical Railway System; Samuel F. B. Morse, of Brooklyn, N. Y. Application filed Oct. 29, 1890. An electrical railway system comprising an overhead trolley-conductor and an insulated or underground conductor, both being divided into corresponding and independent sections, switch-levers or devices at the junctions of said sections for connecting a conductor of one section with a conductor of another, whereby a section of one circuit may be substituted for its corresponding section in the other, electromagnets for operating said switch-levers and supplemental circuits co-extensive with and corresponding to the sections of the main conductor, including such magnets, and adapted to be controlled by the movements of the cars along the line of the conducters.

449,246. Electric Arc Lamp; John H. R. Ward, of New York, Assignor to the Universal Arc Lamp Company, of same place. Application filed Dec. 8, 1890. An electric arc lamp globe-holder, consisting of the combination of a globe-socket, elastic and flexible rods carried thereon, two rings at the opposite ends of each rod at right angles to each other and said rods and passing through one of the rings on each rod, hooks attached to the remaining rings, supports, such as pins attached to said tubes for the purpose of supporting said hooks, and crosspiece connecting the lower ends of said tubes and provided with holes through which pass said rods.

449,237. Electric Arc Lamp; John H. R. Ward, of New York, Assignor to the Universal Arc Lamp Company, of same place. Application filed Dec. 8, 1890. This invention involves means in connection with the lamp for ventilating the regulating coils, and for connecting up the coil according to the circuit in which it is included.

449,238. Electric Arc Lamp; John H. R. Ward, of New York, Assignor to the Universal Arc Lamp Company, of same place. Application filed Dec. 11, 1890. In an electric arc lamp, the combination, with a regulating resistance coil and operating magnet of a resistance coil in circuit with said coil and magnet, the resistance of the latter coil being substantially two-thirds that of the magnet.

449,245. Dynamo Regulator; Burnett H. Fisher, of New York. Application filed Sept. 15, 1890. A dynamo consisting of the combination of stationary and movable field magnets, commutator brushes, and means for communicating motion from the movable field magnet to the said brushes. (See illustration.)

449,254. Telephone; Wm. Humans, of Cambridge, Mass., Assignor to the American Magnetic Electric Company, of Jersey City, N. J. Application filed July 23, 1885. The invention is a telephone which consists essentially of a compound permanent magnet consisting of at least two permanent magnets, each forming a portion of an annular or rectangular case, a diaphragm, and one or more pole pieces, the free end of each pole piece being within the case and under the diaphragm.

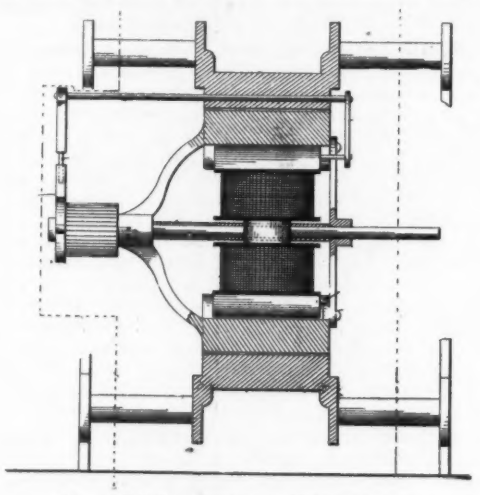
449,258. Method and Apparatus for Electric Soldering; Almon Robinson, of Lewiston, Me. Application filed April 18, 1890. The process of electric soldering, which consists in passing an electric current through the solder to be used, thereby melting the solder solely or principally by the heating effect, which is proportional to its own ohmic resistance, and thereafter applying the melted solder to the joint to be made.

449,266. Hanger-Board for Electric Fixtures; Geo. R. Lean, of Boston, Mass., Assignor to the Bernstein Electric Company, of Portland, Me. Application filed June 9, 1890. In accordance with this invention, two line wires blocks are mounted on a base to which the line wires are connected. A switch is also provided, it comprising two stationary members and a removable member. The removable member is secured or connected with the fixture rod, it having two conducting portions or plates, which are adapted to engage or contact with the stationary members of the switch or connection.

449,282. Electric Switch; Horace T. Clark, of Bridgeport, Conn. Application filed Feb. 25, 1891. A switch consisting of terminal blocks having opposed faces, contact brushes having their ends secured to the side of the blocks, and extending over the ends of said blocks, and then obliquely downward and outward therefrom, and a circuit-closer in the form of a truncated wedge, and means for driving it downward between the terminals.

449,288. Regulating Apparatus for Electric Currents; Wilhelm Labmeyer, of Aix-la-Chapelle, Germany. Application filed Feb. 9, 1888. An electric apparatus consisting of a cistern of mercury, having floats and multiple contacts combined with a series of relays arranged on high resistance shunts, successively thrown into action by varying strength of current in the main lead, and by their action throwing into the main circuit one by one a series of resistances, so as to cause the resistance of the main lead to diminish as the strength of current increases, and the reciprocal.

449,289. Fuse for Electric Circuits; Francis W. Maxstadt, of Chicago, Ill. Application filed Jan. 10, 1891. A safety fuse for electric currents, comprising a plate of insulating material, having a strip of metal, sufficiently attenuated to be fused by a current having the power of at most about one-half an ampère and



No. 449,245.—DYNAMO REGULATOR.

cemented to one side of the said plate to extend lengthwise thereof, and metal-foil contact strips, cemented to the plate near its opposite end, and covering the ends of the fuse strip.

449,299. Galvanic Battery; Henry P. Stoecker, of New York. Application filed Dec. 4, 1890. This invention consists in a cathode formed of a series of carbon rods arranged in contact one with the other, and with an inner carbon rod and an intermediate filling of broken carbon and a depolarizing agent.

449,301. Cut-Out; Chas. S. Van Nuis, of New Brunswick, N. J. Application filed Aug. 18, 1890. The invention comprises a non-conducting switch-arm having contacts co-operating with the circuit terminals, a fusible conductor connecting the contacts and a single screen between the terminals and extending between the ends of the fusible conductor.

449,302. Electric Contact Protector; Richard Varley, Jr., of Englewood, N. J. Application filed Nov. 28, 1890. An electric contact protector formed of two discs of flexible material connected together around their edges and having central openings for the electrodes.

449,307. Binding Post for Electric Wires; Henry Price Ball, of Brooklyn, Assignor to the Edison General Electric Company of New York, Application filed Dec 16, 1890. A connector consisting of a member having a groove or depression across its face, the sides of the groove being inclined, a second member having inclined or beveled sides corresponding to the inclined sides of the groove, and means for clamping the two members together.

449,337. Burr Preventer for Electric Welding Machines; Elihu Thomson, of Swampscott, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Aug. 15, 1890. The combination, with a metal-working apparatus having means for imparting end pressure to the work, so as to tend to upset or enlarge the same, of a number of compressing rockers, segments or fans adapted to engage simultaneously with the piece of metal, and pivoted so as to rock or swing individually in planes transverse to the general plane including them, and a support or supports for said rockers adapted to be reciprocated or moved in a direction transverse to said general plane. (See illustration.)

449,345. Electric Belt; Duane P. Andrus, of St. Louis, Mo. Application filed Nov. 7, 1890. In an electric belt, a voltaic couple composed of a zinc plate provided with a perforation and a depression forming one element, a T-shaped copper plate provided with a perforation and the stem of which bent upon itself and adapted to be slipped over one side of said zinc plate through the perforation forming the other element, and suitable layers of dielectric absorbent material to contain the exciting fluid interposed between the folds of said copper and zinc plates.

449,348. Electric Contact; Otis J. Depp, of St. Louis, Mo. Application filed Jan. 24, 1891. An electric contact device consisting of a base-plate, an arm hinged thereto and adapted for contact with a co-operating contact, a rigid arm provided with a bore secured to the same, a spiral spring located in said bore, and an insulating plug located in the same and mounted on said spring for deflecting the current and preventing the same from passing through said spring. (See illustration.)

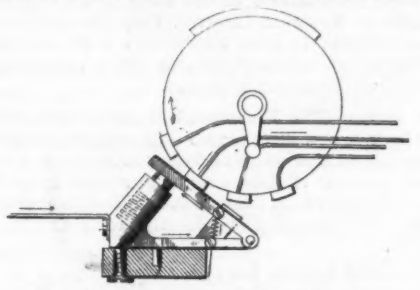
449,356. Manufacturing Chains by Electric Welding Processes; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed April 23, 1890. The invention consists in constructing each link of a single continuous piece of metal, the opposite ends of which are abutted at the joint of the loop or link, heating each link at the joint as well as at the continuous part of the link opposite thereto, and then subjecting the link to pressure in a line transverse to the link connecting the joint and the opposite heated portion.

449,358. Electro-Magnet; Ferdinand A. Wessel, of Brooklyn, N. Y. Application filed Nov. 19, 1890. In a sectional electro-magnet, a retaining head or flange for the coils, having an elongated slot or opening near its inner edge and parallel to the face of the pole or core, in combination with leading wires for the coil sections passing through said slot and resting upon the pole face in a single flat layer.

449,363. Electric Switch-Box; Jas. H. Dean, of Minneapolis, Minn., Assignor by direct and mesne assignments to Barron D. Southard, of same place, and Wm. Perkins, of Armada, Mich. Application filed Nov. 4, 1890. The combination in an electric switch-box of a central shaft provided with a contact brush, a contact-ring, a resistance-drum provided on said shaft, an armature provided on said drum, and an electro-magnet adapted to magnetically engage said armature, and means whereby said shaft, when not held by the electro-magnet or by the switch-lever, is turned back and held in its normal position.

449,400. Insulated Electric Conductor; James D. Bishop, of Brooklyn, N. Y. Application filed Sept. 22, 1890. An electric conductor comprising a conducting-core wound with a paper ribbon, the spiral edges of which are separated by a spiral air space and inclosed within a protective sheath.

449,404. Electric Heating Apparatus; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same



No. 449,348.—ELECTRIC CONTACT.

place. Application filed April 28, 1890. The combination of an exposed electric heater and a ventilating fan mounted upon the same support or frame.

449,411. Electric Alarm for Shaft-Bearings; George Hannah, of Brooklyn, N. Y. Application filed Dec. 24, 1890. A shaft bearing having circuit terminals insulated from each other below the normal wearing surface, and an electric circuit connected to said terminals.

449,474. Electric Lighting System; George Gibbs, of Milwaukee, Wis. Application filed Aug. 14, 1890. In an electric lighting system, two main leads from the generator, and the main lights connected to and between said leads, in combination with a storage battery, conductors connecting said battery with the two leads, a resistance in one of said conductors between the battery and the main lead, an auxiliary circuit containing lamps and connected with the storage battery, and an automatic switch mechanism whereby the battery is held normally in circuit with the leads and the auxiliary circuit held open, but on the cessation of the current through the main circuit the auxiliary current is completed through the battery.

449,490. Guard for Electric Railway Trolleys; Andrew W. Mitchell, of Boston, Mass. Application filed Dec. 1, 1890. The combination with a trolley wheel and two arms, a cross bar connecting the arms together, each arm having a curved slot and a flange extending over the wheel, and arm at its side having a pin engaging with the journal pin of the trolley wheel of a lever pivoted to the trolley rod and engaging with the cross bar of the flange arms.

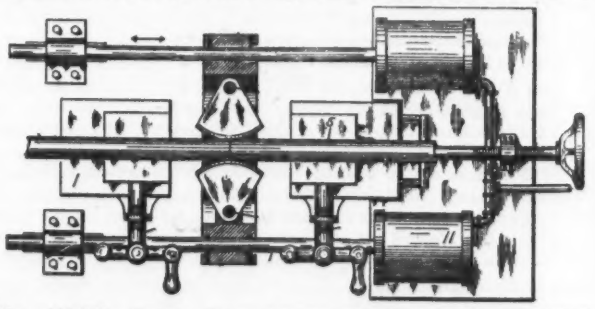
449,569. Automatic Trolley Catcher for Electric Railways; Byron J. Parsons, of Omaha, Neb., Assignor to Fred. W. Fitch, of same place. Application filed Aug. 27, 1890. The trolley catcher comprising a box or casing, a winding drum or cylinder journaled therein, an actuating spring in said drum or cylinder, a ratchet on the end of the drum shaft and a pawl in engagement therewith, a trip for said pawl and a flexible connection with the trolley rope.

449,574. Repeater; Fred W. Cole, of Newton, Mass., Assignor of one half to Moses G. Crane, of same place. Application filed May 12, 1890. A repeater having two or more relays, each in a separate main circuit, armatures therefor, a locking device for each armature, and a governing electro-magnet for each locking device with a circuit-changer for the circuit of said governing electro-magnets, and a controlling member therefor movable quickly in one direction and slowly in the other direction.

449,575. Non-Interference Signal Box; Fred. W. Cole, of Newton, Mass., Assignor of one-half to Moses G. Crane, of same place. Application filed June 9, 1890. In a signal box, a signaling train, a locking lever, a spring-controlled holder therefor, combined with a pull and a box-controller, between which the said holder is interposed.

449,576. Non-Interference Signal Box; Fred. W. Cole, of Newton, Mass., Assignor of one-half to Moses G. Crane, of same place. Application filed Oct. 20, 1890. In a non-interference signal box, signal mechanism, a non-interference magnet and its armature, combined with a locking arm and a fulcrum lever, and fulcrum therefor, the position of which is controlled by said armature.

449,604. Incandescent Electric Lamp Socket; Franklin A. Weller, of Boston, Mass., Assignor to William S. Hadaway, Jr., Trustee, of same place. Application filed Aug. 11, 1890. In a holder or socket for electric lamps, the combination with the in-



No. 449,337.—BURR PREVENTER FOR ELECTRIC WELDING MACHINES.

ternal casing containing the contacts and provided with an opening through its walls to the inner mechanism of the outer jacket or casing surrounding the inner casing, movable thereon, and having an opening registering with the opening therein, and the key journaled in the inner casing and projecting through the outer casing.

449,610. Magnetic Separator; Rich. R. Moffatt, of New York, Assignor to himself and Sylvester Chichester, of Brooklyn, N. Y. Application filed Aug. 25, 1890. In a magnetic separator the combination of two rotating drums with a stationary electro-magnet or magnets located outside of the drums and having pole pieces or extensions within the drums.

449,611. System of Operating Electric Elevators; Wm. Baxter, Jr., of Baltimore County, Md. Application filed March 17, 1888. In an electric elevator system, in which the motion of an electric motor is transmitted to the car by means of a hoisting pulley, intermediate mechanism and a hoisting rope, the combination with the motor circuit of a switch located upon the car and arranged and operated to reverse the motion of a car by reversing the motor and to stop the car by stopping the motor.

449,639. Electric Railway Signal; Stonewall Tompkins, of Knoxville, Tenn., Assignor of one-half to Chas. E. Vawter, of Crozet, Va. Application filed Dec. 9, 1889. In an electric railway signal system, a series of aligned conductor sections, electrically connected into groups, a second series of aligned conductor sections similarly connected into groups, the arrangement being such that each section exists between sections belonging to a group or groups other than its own, and groups in one series being connected with the respective groups of the other series.

449,651. Electro-Therapeutic Syringe; Edwin Bartsch, of San Francisco, Cal. Application filed June 28, 1890. A medical syringe composed of a cylindrical case or shell having a chamber formed therein, and suitable means to charge said chamber with electricity.